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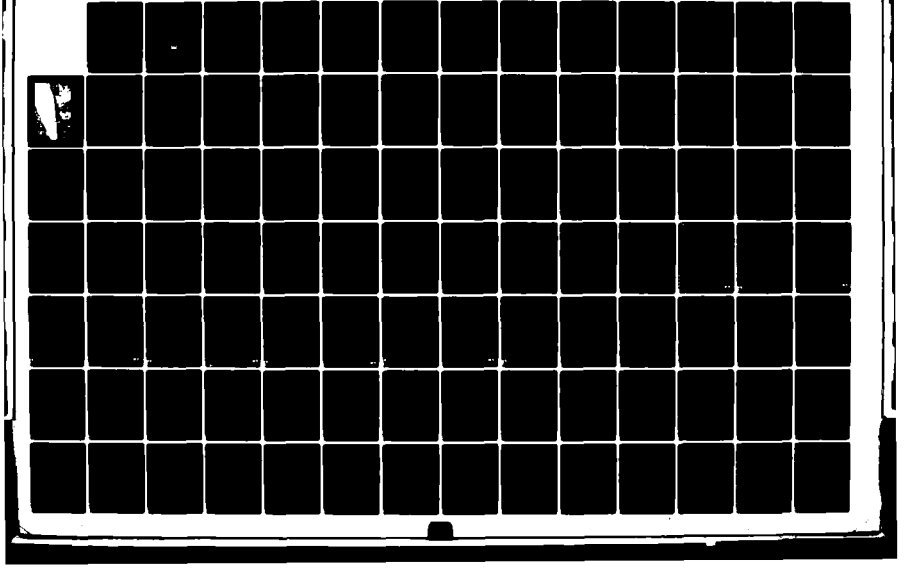

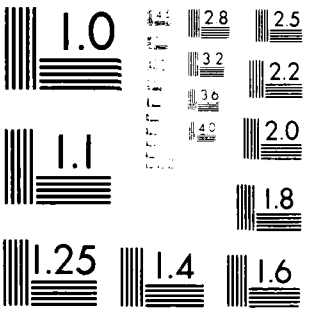

NAUGATUCK RIVER BASIN

PLYMOUTH, CONNECTICUT

PLYMOUTH RESERVOIR DAM
CT 00286

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

MAY 1981

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Naugatuck River Basin
Plymouth, Connecticut

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Plymouth Reservoir Dam, also known as the Thomaston Reservoir Dam, consists of an earth embankment structure with a maximum height of 25 ft. and a total length of 730 ft. including a 31.7 ft. long concrete and stone masonry overflow spillway located 200 ft. from the right end of the dam. Based on the visual inspection, the dam is judged to be in fair condition. The dam is classified as "Small" in size and with a "High" hazard potential.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:

NEDED

JUL 28 1981

Honorable William A. O'Neill
Governor of the State of Connecticut
State Capitol
Hartford, Connecticut 06115

Dear Governor O'Neill:

Inclosed is a copy of the Plymouth Reservoir Dam (CT-00286) Phase I Inspection Report, prepared under the National Program for Inspection of Non-Federal Dams. This report is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. I approve the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is vitally important.

Copies of this report have been forwarded to the Department of Environmental Protection, and to the owner, Connecticut Water Company, Clinton, CT. Copies will be available to the public in thirty days.

I wish to thank you and the Department of Environmental Protection for your cooperation in this program.

Sincerely,

C. E. EDGAR, III
Colonel, Corps of Engineers
Commander and Division Engineer

Incl
As stated

PLYMOUTH RESERVOIR DAM
CT 00286

NAUGATUCK RIVER BASIN
PLYMOUTH, CONNECTICUT

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

49-046

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

IDENTIFICATION NO: CT 00286

NAME OF DAM: Plymouth Reservoir Dam (a/k/a Thomaston Reservoir Dam)

TOWN: Plymouth

COUNTY AND STATE: Litchfield County, Connecticut

STREAM: Tributary to the Naugatuck River

DATE OF INSPECTION: April 28, 1981

BRIEF ASSESSMENT

Plymouth Reservoir Dam, also known as the Thomaston Reservoir Dam, consists of an earth embankment structure with a maximum height of 25 feet and a total length of 730 feet including a 31.7 foot long concrete and stone masonry overflow spillway located 200 feet from the right end of the dam. The outlet works, located to the left of the spillway, consist of a 12-inch supply main and 10-inch low level outlet or blowoff through the dam, and an upstream gate-house.

The dam is owned by the Connecticut Water Company and impounds Plymouth Reservoir, a storage reservoir for public water supply.

Based on the visual inspection, the dam is judged to be in fair condition. Features that could affect the future integrity of the dam are downstream seepage, the lack of riprap slope protection on the upstream slope above the waterline and settlement of existing riprap, the unknown working condition of the intake gates, and the downstream location of the control valve on the low level outlet or blowoff.

The dam is classified as "Small" in size with a "High" hazard potential. A Test Flood equal to one-half the Probable Maximum Flood (1/2 PMF) was selected in accordance with the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams. The Test Flood inflow of 600 cfs results in a Test Flood routed outflow of 390 cfs that would just reach the top of the dam.

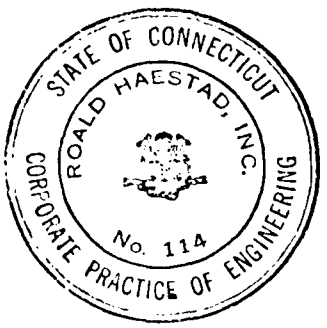
The spillway capacity is 410 cfs or 105 percent of the Test Flood routed outflow.

It is recommended that a qualified, registered engineer be retained to investigate the downstream seepage, the condition and adequacy of the upstream riprap, the condition of the intake gates and the low level outlet or blowoff. In addition, an Operations and Maintenance Manual should be prepared and a downstream warning system should be put into effect.

The owner should implement these recommendations as described herein and in greater detail in Section 7 of this Report within one year of receipt of this Phase I Inspection Report.

Ronald G. Litke, P.E.
Project Engineer

Roald Haestad
President



This Phase I Inspection Report on Plymouth Reservoir Dam (CT-00286) has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgement and practice, and is hereby submitted for approval.

JOSEPH W. FINEGAN, JR., MEMBER
Water Control Branch
Engineering Division

ARAMAST MAHTESIAN, MEMBER
Geotechmical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, CHAIRMAN
Design Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the

condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I Inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety of the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

TABLE OF CONTENTS

INDEX TO REPORT

INDEX TO APPENDIXES

OVERVIEW PHOTO

U.S ARMY ENGINEER DIV NEW ENGLAND WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS	
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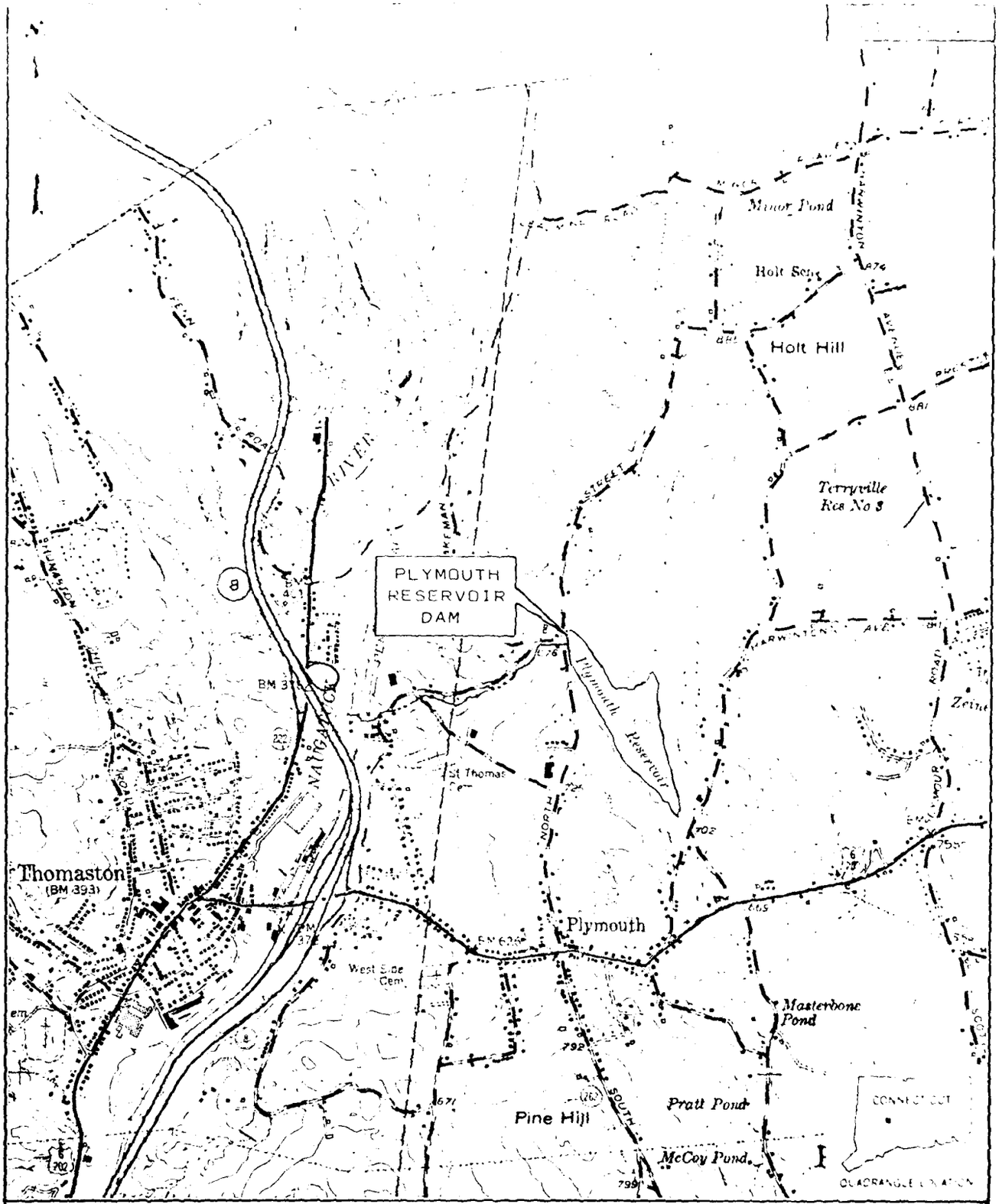


LOCATION PLAN

PLYMOUTH RESERVOIR DAM
PLYMOUTH, CONNECTICUT

SCALE: 1" = 2000'

ROALD HAESTAD, INC. THOMASTON QUADRANGLE 1969

PLYMOUTH RESERVOIR DAM

PROJECT INFORMATION
SECTION 1

1.1 General

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Roald Haestad, Inc., has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed were issued to Roald Haestad, Inc. under a letter of March 30, 1981, from William E. Hodgson, Jr., Colonel, Corps of Engineers. Contract No. DACW33-80-C-0048 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection

The purposes of the program are to:

1. Perform technical inspection and evaluation of non-federal dams to identify conditions requiring correction in a timely manner by non-federal interest.
2. Encourage and prepare the States to quickly initiate effective dam inspection programs for non-federal dams.
3. To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location

The dam is located in the Town of Plymouth opposite the intersection of Blakeman Road with North Street. The dam is shown on the Thomaston U.S.G.S. Quadrangle map having coordinates of latitude N41°-41.1' and longitude W73°-03.2'.

b. Description of Dam and Appurtenances

The Plymouth Reservoir Dam, also known as the Thomaston Reservoir Dam, is an earth embankment structure with a total length of 730 feet, including a 31.7 foot long concrete and stone masonry overflow spillway located 200 feet from the right end of the dam. The outlet works are located to the left of the spillway. The earth embankment has a top width of 15 feet, an upstream slope of 3 horizontal to 1 vertical, and a downstream slope that varies from 3-1/4 horizontal to 1 vertical at the spillway to 5 horizontal to 1 vertical near the left abutment of the dam. The upstream slope is protected by a layer of riprap. There are sand and gravel drainage blankets on the downstream slopes which connect to 8-inch corrugated metal toe drains that outlet into the spillway discharge channel. Plans indicate that a cemented rubble masonry corewall extends the entire length of the dam. According to the Plans the bottom of the corewall is 5 feet below the original grade and the top of the corewall is 1-1/2 feet below the top of the dam. In 1975 test borings were made and piezometers were installed.

The spillway consists of a concrete and stone masonry structure. The lower portion of the spillway is constructed of stepped stone masonry, while the upper 5 feet consists of a concrete

overflow weir. In 1977, gabions were placed against the inside face of the downstream concrete training walls in order to install drainage blankets and flatten the downstream slopes of the dam.

At the left end of the dam there is a 50 foot long emergency earth spillway with a maximum depth of 1 foot below the crest of the dam.

The outlet works consist of a gatehouse containing manually operated intake gate valves at varying elevations, and screening facilities. A 12-inch pipe through the dam transports water from the gatehouse to chemical treatment facilities below the dam where reservoir water is treated prior to entering the distribution system. A 10-inch low level outlet or blowoff pipe discharges into the brook below the dam. It is not known how this pipe is connected to the reservoir or gatehouse. At the present time the outlet is controlled by a downstream gate.

c. Size Classification - "Small"

According to the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams, a dam is classified as "Small" in size if the height is between 25 feet and 40 feet or the dam impounds between 50 Acre-Feet and 1,000 Acre-Feet of water. The dam has a maximum height of 25 feet and a maximum storage capacity of 390 Acre-Feet. Therefore, the dam is classified as "Small" in size.

d. Hazard Classification - "High"

Based upon the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams, the hazard classification of the dam is "High". A dam failure analysis indicates that a failure

of the Plymouth Reservoir Dam could result in the loss of more than a few lives.

The calculated flood wave would overtop North Street by about 9 feet, inundate two houses and the Connecticut Water Company Treatment Facilities immediately below the dam, then continue down the valley where it would overtop Altair Avenue and Railroad Street by up to 11 feet and flood five houses on the south side of Railroad Street to a depth of 2 to 10 feet. The flood waters would then overtop a downstream railroad embankment by about 3 feet and discharge to the Naugatuck River. The impoundment created by the railroad embankment would flood several houses to a maximum depth of 15 feet.

Prior to dam breach the maximum spillway discharge would overtop North Street, Altair Avenue and Railroad Street by about 1 foot flooding one house downstream of Railroad Street to an unknown depth.

e. Ownership

Former Owner: Thomaston Water Company

Present Owner: Connecticut Water Company
93 West Main Street
Clinton, Connecticut 06413
(203) 669-8636
Kenneth Kells, Supervisor

f. Operator

William Dunn, Division Manager
Connecticut Water Company
Naugatuck Division
250 Meadow Street
Naugatuck, Connecticut 06770
(203) 729-8241

g. Purpose of Dam

The dam impounds Plymouth Reservoir, a storage reservoir for public water supply.

h. Design and Construction History

The dam was designed by William B. Rider, Hydraulic Engineer, in 1880, and constructed by Fred T. Ley and Company, Contractors, between 1880 - 1881. In 1910 the dam was raised 16 inches and the embankment strengthened. In 1921 additional work involving riprap on the dam was performed. In 1977 repairs were made to the dam which consisted of placing gabions inside the concrete spillway walls in order to install downstream drainage blankets and toe drains, and to flatten the downstream slopes. The repairs were designed by Metcalf and Eddy, Inc., and constructed by the Connecticut Water Company.

i. Normal Operating Procedures

The upper intake gate is left open and water is drawn from the reservoir when storage is adequate.

1.3 Pertinent Data

a. Drainage Area

The drainage area consists of 0.57 square miles of "rolling" wooded hills with scattered residential development.

b. Discharge at Damsite

Discharge at the damsite is over the 31.7 foot long overflow spillway. A 12-inch supply main transports water from the reservoir to the distribution system, and a 10-inch low level outlet or blowoff discharges downstream of the dam.

1.	Outlet Works (conduits) Size:	
	Supply Main:	12-inch
	Low Level Outlet:	10-inch
	Invert Elevation at Gatehouse:	
	Supply Main:	672±
	Low Level Outlet:	672±
	Discharge Capacity:	
	Supply Main:	Unknown
	Low Level Outlet:	6 cfs
2.	Maximum Known Flood at Damsite:	Unknown, did not overtop in 1938 or 1955
3.	Ungated Spillway Capacity at Top of Dam:	410 cfs
	Elevation:	694.5
4.	Ungated Spillway Capacity at Test Flood Elevation:	390 cfs
	Elevation:	694.5 (-)
5.	Gated Spillway Capacity at Normal Pool Elevation:	N/A
	Elevation:	N/A
6.	Gated Spillway Capacity at Test Flood Elevation:	N/A
	Elevation:	N/A
7.	Total Spillway Capacity at Test Flood Elevation:	390 cfs
	Elevation:	694.5 (-)
8.	Total Project Discharge at Top of Dam:	410 cfs
	Elevation:	694.5
9.	Total Project Discharge at Test Flood Elevation:	390 cfs
	Elevation:	694.5 (-)

c. Elevation - Feet Above Mean Sea Level (MSL)

1. Streambed at Toe of Dam:	667.1
2. Bottom of Cutoff:	666.5
3. Maximum Tailwater:	N/A
4. Normal Pool:	692.0
5. Full Flood Control Pool:	N/A
6. Spillway Crest:	692.0
7. Design Surcharge - Original Design:	694.5
8. Top of Dam:	694.5
9. Test Flood Surcharge:	694.5 (-)

d. Reservoir - Length in Feet

1. Normal Pool:	3,200 feet
2. Flood Control Pool:	N/A
3. Spillway Crest Pool:	3,200 feet
4. Top of Dam:	3,300 feet
5. Test Flood Pool:	3,300 feet

e. Storage - Acre-feet

1. Normal Pool:	290 Acre-Feet
2. Flood Control Pool:	N/A
3. Spillway Crest Pool:	290 Acre-Feet
4. Top of Dam:	390 Acre-Feet
5. Test Flood Pool:	390 Acre-Feet

f. Reservoir Surface - Acres

1. Normal Pool:	36.7 Acres
2. Flood-Control Pool:	N/A
3. Spillway Crest:	36.7 Acres
4. Test Flood Pool:	40.7 Acres
5. Top of Dam:	40.7 Acres

g. Dam

1.	Type:	Earth Embankment
2.	Length:	730 feet
3.	Height:	25 feet
4.	Top Width:	15 feet
5.	Side Slopes:	Upstream: 3 horizontal to 1 vertical Downstream: Varies 3.25 - 5 horizontal to 1 vertical
6.	Zoning:	Original embankment of selected gravel and clay constructed by puddling. Drainage blanket consisting of 16-inches of concrete sand over original embankment, with remaining embankment of bankrun gravel.
7.	Impervious Core:	Cemented rubble masonry core wall to within 1.5 feet of top of dam. 3 feet wide at top; 5 feet wide at base.
8.	Cutoff:	Core wall extends 5 feet below original ground.
9.	Grout Curtain:	None
10.	Other:	

h. Diversion and Regulating Tunnel - N/A

i. Spillway

1.	Type:	Broad crested overflow weir. Upper portion of concrete; lower portion of stepped stone masonry.
2.	Length of Weir:	31.7 feet
3.	Crest Elevation with Flash Boards: without Flash Boards:	 N/A 692.0
4.	Gates:	N/A
5.	Upstream Channel:	Stone-lined approach channel with concrete training walls.
6.	Downstream Channel:	Stone-filled mat (gabions) at base of spillway. Flows into 48-inch culvert that discharges to natural stream.
7.	General:	

j. Regulating Outlets

1.	Invert:	$672^{\pm}$
2.	Size:	10-inch
3.	Description:	Cast iron pipe through dam; outlet end is asbestos cement pipe.
4.	Control Mechanism:	Manually operated downstream gate.
5.	Other:	12-inch supply main

2.1 Design Data

Information on the original design is listed in a report entitled "Investigation of Seepage and General Condition of the Plymouth Reservoir Dam" by Metcalf and Eddy, Inc., August 19, 1975. See Appendix B, pages B-28 through B-46. The report refers to the Contract Documents for the original dam. Also included in the report are soil borings and design recommendations for repairs to the dam. Computations by Metcalf and Eddy, Inc. for flood routing of a 100-year storm were available and reviewed. Plans and Specifications entitled "Town of Plymouth, Thomaston Water Company, Plymouth Reservoir Dam Repairs", Metcalf and Eddy, Inc., 7/21/77, were available and reviewed. Also available was an inspection report prepared for the State of Connecticut, Department of Environmental Protection, by S. E. Minor and Company, Inc., Civil Engineers, July 15, 1974, and plans of the dam and gatehouse prepared by The Henry Souther Engineering Company in 1932.

2.2 Construction Data

Construction data consists of the Plans and Specifications for the repairs to the dam in 1977, and inspection photos, reports and notes by the Connecticut Water Company concerning the repairs.

2.3 Operation Data

Lake levels are recorded weekly, and do not necessarily coincide with maximum water levels. It was reported that the dam did not overtop during the hurricane floods of 1938 and 1955. Monthly inspection reports and records of the piezometer readings are available from the Connecticut Water Company.

2.4 Evaluation of Data

a. Availability

Existing data was available from the Connecticut Water Company and the State of Connecticut, Department of Environmental Protection.

b. Adequacy

The information that was available, along with the visual inspection, past performance history, and hydraulic and hydrologic calculations were adequate to assess the condition of the dam.

c. Validity

Field inspections and surveys revealed that the dam is constructed substantially as indicated by the existing data. The length of the spillway weir following the 1977 repairs is 31.7 feet, as opposed to the 40 foot length used in the flood routing for the 100-year design storm.

3.1 Findings

a. General

The visual inspection of the dam was conducted on April 28, 1981. The inspection team was accompanied by Mr. Kenneth Kells and Mr. Roland Baillargeon of the Connecticut Water Company. At the time of the inspection the water level was slightly below spillway level.

The Plymouth Reservoir Dam consists of an earth embankment structure with a concrete and stone masonry overflow spillway located 200 feet from the right end of the dam and outlet works at the left end of the spillway, Photos 1 and 2.

The general condition of the dam at the time of inspection was fair.

b. Dam

The crest of the dam is grass-covered and appears to be fairly level for the entire length of the dam, Photo 2. In cross section, the crest appears to be somewhat rounded and tire paths are evident on the left side of the dam, Photo 3. At the right end of the dam there is a dug well which supplies water to a downstream house. At the time of inspection, the water level in the well was about 10 inches lower than the reservoir level. The upstream slope is protected by a layer of riprap which extends to a maximum of 1 foot above the waterline, Photos 2 and 3. A portion of the riprap near the left end of the dam appears to have settled slightly.

The downstream slope is covered with grass, Photos 1 and 4. A wet area approximately 30 feet long and 8 feet wide,

located about 100 feet to the left of the spillway, was observed on the downstream slope of the dam, Photo 4. The area was saturated and contained numerous animal footprints approximately 3 - 4 inches deep that were filled with water. There was no noticable flow of water from this area. Some seepage was observed in the gutter of the road near the left end of the dam, Photo 5. The area was covered with rust-colored floccules, however, the seepage appeared clear at the time of inspection. The seepage flows into a 24-inch perforated, corrugated metal pipe drain, and discharges into a 48-inch culvert downstream of the spillway. The flow at the discharge end of the 24-inch drain was approximately 1 gpm.

Plans indicate that sand and gravel drainage blankets were constructed on the downstream slopes and discharge into 8-inch ACCMP toe drains which outlet into the spillway discharge channel, Photo 6. There was no flow discharging from either toe drain at the time of inspection, however, the left toe drain was wet. A 15-inch perforated, corrugated metal pipe storm drain at the right side of the spillway discharge channel was discharging approximately 5 gpm at the time of inspection. The total flow at the discharge end of the 48-inch culvert under the Town road was 15 gpm.

Six piezometers are present on the downstream slope, four to the left of the spillway and two to the right. Records of past readings are contained in Appendix B, pages B-55 - B-58.

c. Appurtenant Structures

The appurtenant structures consist of the overflow spillway, the outlet works and an emergency earth spillway.

Spillway

The overflow spillway consists of a concrete and stone masonry structure, Photos 7 and 8. The lower portion of the spillway is constructed of stepped stone masonry with the joints plastered with mortar. The upper portion and weir are constructed of concrete. The concrete appears to be in good condition with some minor spalling of the concrete training walls below the waterline. The left end of the spillway crest was wet indicating that this end may be slightly lower in elevation. At the right end of the spillway, a puddle on the stone masonry at the base of the concrete section may indicate seepage between the concrete and stone masonry. The concrete training walls were lined with stone filled gabions when the downstream slopes were flattened and drainage blankets installed. A filter fabric is present between the embankment and the gabions. The gabions appear to be in good condition, Photos 7 and 8, with no settlement observed behind them. The installation of the gabions reduced the spillway length from 40 feet to 31.7 feet.

Outlet Works

The outlet works consist of a gatehouse located at the left end of the spillway and a 12-inch supply main and 10-inch low level outlet or blowoff through the dam. The stone masonry of the gatehouse appears to have been recently mortared and to be in good condition, Photo 9. The working condition of three manually operated intake gates is unknown. The low level outlet or blowoff and the supply main are normally controlled by gates located downstream of the road near the filter plant. The gatehouse also contains a screen chamber and compressor for an aeration system, Photo 10. The low level outlet or blowoff discharges through a 10-inch asbestos cement pipe approximately 200 feet below the dam, Photo 11.

Emergency Spillway

There is an earth emergency spillway at the left end of the dam, Photo 12. The spillway discharges into the roadway which runs parallel to the toe of the dam.

d. Reservoir Area

There were no indications of instability along the edges of the reservoir in the vicinity of the dam.

e. Downstream Channel

Immediately downstream of the spillway the channel floor is lined with a stone-filled mat, Photo 6. Approximately 50 feet downstream of the dam the spillway channel flows into a 48-inch reinforced concrete culvert under a Town road and then into a natural streambed. The natural streambed consists of gravel and cobbles. There are trees overhanging the stream and the remains of a small dam are located several hundred feet below the spillway.

3.2 Evaluation

Based on the visual observations, the dam appears to be in fair condition. The following features could affect the future integrity of the dam:

1. Seepage downstream of the dam and on the downstream slope may cause internal erosion leading to piping failure of the embankment.
2. The lack of riprap above the waterline and continued settlement of the existing riprap on the upstream slope may lead to erosion and reduction of crest width.
3. The use of the downstream gates to control flow and the unknown working condition of the intake gates permit

full water pressure to exist in the outlet pipes through the dam and may not allow for flow to be shut off in the event of a leak in the outlet pipes.

SECTION 4

4.1 Operational Procedures

a. General

Plymouth Reservoir is a water storage reservoir which is used to supplement alternate sources of water supply. Water is drawn from the reservoir when the storage is adequate. The upper intake gate in the gatehouse remains open at all times and flow is controlled by a downstream gate. The downstream low level outlet or blowoff gate is operated once a year. The dam is inspected on a monthly basis by maintenance personnel and semi-annually by the owner's Engineering Department. Water levels in the piezometers are read as part of all the inspections.

b. Description of Any Warning System in Effect

A formal warning system is being prepared for the dam. At the present time the dam is monitored during large storms.

4.2 Maintenance Procedures

a. General

The grass on the dam is mowed once a month during the mowing season.

b. Operating Facilities

The low level outlet or blowoff is opened once a year to insure its operation. The screens within the gatehouse are cleaned annually.

4.3 Evaluation

Present Operational and Maintenance Procedures are generally adequate but need to be improved. In addition to the formal warning system which is currently being prepared, an Operations and Maintenance Manual should be prepared for the dam.

5.1 General

The spillway at Plymouth Reservoir Dam consists of a 31.7 foot long broad-crested overflow weir with a stepped downstream face of mortared stone masonry. The spillway is located about 200 feet from the right end of the dam. The top of the dam is about 2.5 feet above the spillway level.

Stone filled gabions have been placed inside the downstream concrete training walls in order to install drainage blankets on the downstream slopes of the dam. Approximately 50 feet downstream of the spillway, the spillway channel flows into a 48-inch reinforced concrete culvert under a Town road (North Street).

The dam has a maximum height of 25 feet and a storage capacity of 390 Acre-Feet with the water level at the top of the dam. A grass-covered emergency spillway with a length of 50 feet and a maximum depth of about 1 foot below the crest of the dam is located at the left abutment. The capacity of this spillway was given as only 5 to 8 cfs, and therefore was not included in the Test Flood computations. (See pages B-15 and B-16 in Appendix B.)

The tributary watershed area is 0.57 square miles of "rolling" wooded hills with scattered residential development. The watershed elevations range from 950 feet at the north end to 692 feet at the dam.

5.2 Design Data

The spillway and dam were rebuilt in 1977, as designed by Metcalf and Eddy, Inc., of Boston, Massachusetts. The Kennison-

Colby Rare Flood Method was used to develop the inflow hydrograph for a 100-year design storm. The peak inflow was calculated to be 850 cfs with a depth of runoff of 7.09 inches and a peak outflow of 362 cfs. A 40 foot spillway length was used in the computations; actual spillway length after reconstruction is 31.7 feet. The computations are shown in Appendix B, pages B-12 through B-27.

5.3 Experience Data

It was reported that the dam did not overtop during the hurricane floods of 1938 and 1955.

5.4 Test Flood Analysis

Based on the dam failure analysis, the dam is classified as "High" hazard potential. The dam was classified as "Small" in size based on a height of 25 feet and a storage capacity of 390 Acre-Feet. According to the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams, the Test Flood for a "Small" dam with a "High" hazard potential should be in the range of one-half the Probable Maximum Flood (1/2 PMF) to the Probable Maximum Flood (PMF).

A Test Flood equal to the 1/2 PMF was selected because of the low hydraulic height and small storage capacity of the dam. The Test Flood was calculated using a peak inflow for the PMF of 2,125 cubic feet per second per square mile (csm) from the minimum two square mile drainage area shown on the Corps of Engineers' Guide Curves for "rolling" terrain and the 0.57 square mile watershed of Plymouth Reservoir Dam. The peak 1/2 PMF inflow was calculated to be 600 cfs, resulting in a routed outflow of 390 cfs.

The Test Flood was routed through the impoundment in accordance

with the Corps of Engineers' procedures for "Estimating the Effect of Surcharge Storage on Probable Maximum Discharges". The impoundment was assumed to be initially at spillway level. The spillway is capable of discharging 410 cfs or 105 percent of Test Flood routed outflow.

5.5 Dam Failure Analysis

The Corps of Engineers' ' "Rule of Thumb" Guidance for Estimating Downstream Dam Failure Hydrographs' was used to calculate the peak outflow due to a dam failure. Failure was assumed with the water level at the top of the dam. The 16 foot deep by 152 foot long breach would release up to 16,500 cfs into the stream channel below the dam.

Because of the minimal storage of the steep, narrow downstream channel, the flood peak was assumed not to be reduced. Depths of flow were determined at each section for the dam breach flood wave. The spillway was assumed to be included in the breach and therefore the spillway discharge was not added to the breach flow.

The flood wave would overtop North Street by about 9 feet and would inundate two houses and the Connecticut Water Company Treatment Facilities on North Street immediately below the dam to a depth of 1 to 5 feet. The depth of flow in the stream channel would be about 15 feet and would flood five houses on the south side of Railroad Street to a depth of 2 to 10 feet. The flood wave would continue down the valley and overtop Altair Avenue and Railroad Street by up to 11 feet. See Figure 5, page D-20. The flood waters would overtop a downstream railroad embankment by about 3 feet and discharge to the Naugatuck River. The impoundment

created by the railroad embankment would flood several houses to a maximum depth of 15 feet.

Prior to dam breach, the spillway flow of about 400 cfs would overtop North Street immediately below the dam by about 1 foot. After crossing the road the flow would return to the stream where it would continue down the steep narrow channel at a depth of about 3 feet. The house sills in this area are about 14 feet above the stream channel. Altair Avenue and Railroad Street would be overtopped by about 1 foot, causing flooding of one house on the downstream side of Railroad Street to an unknown depth. The railroad embankment would impound water to a depth of about 8 feet without flooding homes.

The failure of Plymouth Reservoir Dam could result in the loss of more than a few lives. Therefore, the dam is classified as "High" hazard potential.

EVALUATION OF STRUCTURAL STABILITY
SECTION 6

6.1 Visual Observations

The visual observations did not disclose any evidence of present or past structural instability. The future integrity of the dam could be affected by:

1. Downstream seepage;
2. Lack of riprap above the waterline and the settlement of existing riprap; and
3. The unknown condition of the intake gates and the downstream location of the control valve for the low level outlet or blowoff.

6.2 Design and Construction Data

Information on the original design and construction procedures is listed in a report entitled "Investigation of Seepage and General Condition of the Plymouth Reservoir Dam", by Metcalf and Eddy, Inc., August 19, 1975. Design Plans and Specifications for repairs to the dam in 1977 and flood routing for a 100-year storm were available and reviewed.

6.3 Post-Construction Changes

Since the original construction of the dam in 1880-1881, the following changes have been made:

1. The dam was raised 16 inches and the embankment strengthened in 1910.
2. Additional work involving riprap was performed in 1921.

3. In 1977, gabions were placed inside the concrete training walls to allow for the installation of downstream drainage blankets and toe drains, and the flattening of the downstream slopes.

6.4 Siesmic Stability

The dam is located is Seismic Zone 1 and in accordance with the recommended Phase I Guidelines, does not warrant seismic stability analysis.

7.1 Dam Assessment

a. Condition

On the basis of the visual inspection, the dam is judged to be in fair condition. The future integrity of the dam could be affected by:

1. Downstream seepage;
2. The lack of riprap above the waterline and the settlement of the existing riprap; and
3. The unknown condition of the intake gates and the downstream location of the control valve for the low level outlet or blowoff.

An evaluation of the hydraulic and hydrologic features of the dam determined that the spillway is capable of passing 105 percent of the Test Flood routed outflow.

b. Adequacy of Information

The information available was sufficient for performing a Phase I Inspection.

c. Urgency

The recommendations presented in Sections 7.2 and 7.3 should be carried out by the owner within one year of receipt of this report.

7.2 Recommendations

The following recommendations should be carried out under the direction of a qualified, registered engineer:

1. Investigate the significance of the seepage observed

downstream of the dam and the wet area on the downstream slope and the ineffectiveness of the drainage blankets. Design and construct remedial or monitoring measures, as required.

2. Investigate the condition and adequacy of the upstream riprap and design repairs as required.
3. Investigate the condition of the intake gates and recommend necessary repairs to place them in operation.
4. Investigate the low level outlet or blowoff and design an upstream shutoff gate.

The owner should implement all the recommendations made by the engineer.

7.3 Remedial Measures

a. Operation and Maintenance Procedures

1. Fill and reseed tire paths on the dam crest.
2. An Operations and Maintenance Manual should be prepared.
3. The downstream warning system should be completed and put into effect.

7.4 Alternatives

There are no practical alternatives to the above recommendations.

APPENDIX A

VISUAL CHECK LIST WITH COMMENTS

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT: Plymouth Reservoir Dam

DATE: 4/28/81 TIME: 9:45 a.m. WEATHER: Cloudy 50°

W.S. ELEVATION: 691.9 U.S. N/A DN.S
0.1' below spillway

	PARTY	DISCIPLINE
1.	Roald Haestad, P.E. - Roald Haestad, Inc.	Civil/Geotechnical
2.	Ronald G. Litke, P.E. - Roald Haestad, Inc.	Civil/Structural
3.	Donald L. Smith, P.E. - Roald Haestad, Inc.	Civil/Hydrologic
4.	Kenneth Kells, P.E. - Connecticut Water Company	Owner's representative
5.	Roland Baillargeon - Connecticut Water Company	Owner's representative
6.		

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Dam Embankment	RH,RGL,DLS	Good; some downstream seepage and wet areas.
2.	Outlet Works - Intake Structure & Channel	RH,RGL,DLS	Under water; could not be observed.
3.	Outlet Works - Control Tower	RH,RGL,DLS	Operating condition of gates unknown.
4.	Outlet Works - Transition and Conduit	RH,RGL,DLS	12-inch and 10-inch cast iron pipes through dam
5.	Outlet Works - Outlet Structure and Channel	RH,RGL,DLS	No structure; pipe discharges to stream below dam
6.	Outlet Works - Spill. Weir, Appr. & Discharge Chan.	RH,RGL,DLS	Good condition
7.			
8.			
9.			
10.			
11.			
12.			

[illegible] CHECK LIST

PROJECT: Plymouth Reservoir Dam DATE: 4/[illegible]/81

PROJECT FEATURE: Dam Embankment NAME: BH

DISCIPLINE: Civil Engineers NAME: RGL,DLS

AREA ELEVATION	CONDITIONS
DAM EMBANKMENT	
CREST ELEVATION	694.5
CURRENT POOL ELEVATION	691.9
MAXIMUM IMPOUNDMENT TO DATE	Unknown
SURFACE CRACKS	None observed
PAVEMENT CONDITION	Crest is grass-covered; tire paths on crest
MOVEMENT OR SETTLEMENT OF CREST	None observed
LATERAL MOVEMENT	None observed
VERTICAL ALIGNMENT	Good
HORIZONTAL ALIGNMENT	Good
CONDITION AT ABUTMENT AND AT CONCRETE STRUCTURES	Good; no settlement noted
INDICATIONS OF MOVEMENT OF STRUCTURAL ITEMS ON SLOPES	None observed
TRESPASSING ON SLOPES	Animal footprints in wet area on downstream slope
VEGETATION ON SLOPES	Grass-covered; good condition
SLOUGHING OR EROSION OF SLOPES OR ABUTMENTS	None observed
ROCK SLOPE PROTECTION - RIPRAP FAILURES	Riprap does not extend much above the waterline; 1 foot maximum in some areas; settlement noted near left end.
UNUSUAL MOVEMENT OR CRACKING AT OR NEAR TOES	None observed
EMBANKMENT OR DOWNSTREAM SEEPAGE	Some seepage in gutter of road near left end. 30' x 8' wet area on downstream slope 100' left of spillway.
PIPING OR BOILS	None observed
FOUNDATION DRAINAGE FEATURES	No water discharging from toe drains.
TOE DRAINS	No water discharging from toe drains; left drain is wet.
INSTRUMENTATION SYSTEM	Six piezometers on downstream slope; 15 reported; others broken off or below surface.

PERIODIC INSPECTION CHECK LIST

PROJECT: [illegible] River Dam DATE: [illegible]

PROJECT FEATURE: Outlet Works - Intake Channel and Intake Structure NAME: RH

DISCIPLINE: Civil Engineers NAME: RGL,DLS

AREA EVALUATED	CONDITIONS
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
A. APPROACH CHANNEL:	Under water; could not be observed
SLOPE CONDITIONS	
BOTTOM CONDITIONS	
ROCK SLIDES OR FALLS	N/A
LOG BOOM	N/A
DEBRIS	
CONDITION OF CONCRETE LINING	
DRAINS OR WEEP HOLES	
B. INTAKE STRUCTURE:	Under water; could not be observed
CONDITION OF CONCRETE	
STOP LOGS AND SLOTS	N/A

Periodic Inspection Check List

PROJECT: Klamath Reservoir Dam DATE: 4 2[illegible]

PROJECT FEATURE: Outlet Works - Control Tower NAME: RH

DISCIPLINE: Civil Engineers NAME: RGL,DLS

AREA EVALUATED	CONDITIONS
OUTLET WORKS - CONTROL TOWER	
A. CONCRETE AND STRUCTURAL:	
GENERAL CONDITION	Good
CONDITION OF JOINTS	No joints observed
SPALLING	None observed
VISIBLE REINFORCING	None observed
RUSTING OR STAINING OF CONCRETE	Rusting of walkway due to corrosion of piping.
ANY SEEPAGE OR EFFLORESCENCE	None observed
JOINT ALIGNMENT	No joints observed
UNUSUAL SEEPAGE OR LEAKS IN GATE CHAMBER	Chamber normally full of water.
CRACKS	None observed
RUSTING OR CORROSION OF STEEL	None observed
B. MECHANICAL AND ELECTRICAL:	
AIR VENTS	N/A
FLOAT WELLS	N/A
CRANE HOIST	N/A
ELEVATOR	N/A
HYDRAULIC SYSTEM	N/A
SERVICE GATES	Operating condition unknown
EMERGENCY GATES	N/A
LIGHTNING PROTECTION SYSTEM	N/A
EMERGENCY POWER SYSTEM	N/A
WIRING AND LIGHTING SYSTEM IN GATE CHAMBER	Good; used for aeration system

PERIODIC INSPECTION CHECK LIST

PROJECT: Plymouth Reservoir Dam DATE: 5/28/81

PROJECT FEATURE: Outlet Works - Transition & Conduit NAME: RH

DISCIPLINE: Civil Engineers NAME: RGL,DLS

AREA EVALUATED	CONDITIONS
OUTLET WORKS - TRANSITION AND CONDUIT	
GENERAL CONDITION OF CONCRETE	Conduits consist of 12-inch cast iron supply main and 10-inch cast iron low level outlet or blowoff
RUST OR STAINING ON CONCRETE	
SPALLING	
EROSION OR CAVITATION	
CRACKING	
ALIGNMENT OF MONOLITHS	
ALIGNMENT OF JOINTS	
NUMBERING OF MONOLITHS	

PROJECT: Plymouth Reservoir Dam DATE: [illegible]

PROJECT FEATURE: Outlet Works - Outlet Structure and Outlet Channel NAME: [illegible]

DISCIPLINE: Civil Engineers NAME: FGL,DLS

AREA EVALUATED	CONDITIONS
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	No outlet structure; low level outlet or blowoff pipe discharges to natural stream below dam.
GENERAL CONDITION OF CONCRETE	
RUST OR STAINING	
SPALLING	
EROSION OR CAVITATION	
VISIBLE REINFORCING	
ANY SEEPAGE OR EFFLORESCENCE	
CONDITION AT JOINTS	
DRAIN HOLES	
CHANNEL	Natural streambed
LOOSE ROCK OR TREES OVERHANGING CHANNEL	Some trees overhanging channel
CONDITION OF DISCHARGE CHANNEL	Fair

PERIODIC INSPECTION CHECK LIST

PROJECT: Plymouth R[illegible] Weir Dam DATE: 4-[illegible]-81

PROJECT FEATURE: Outlet Works - A. Spillway Weir, Approach & Discharge Channel NAME: EH

DISCIPLINE: Civil Engineers NAME: RGL, DLS

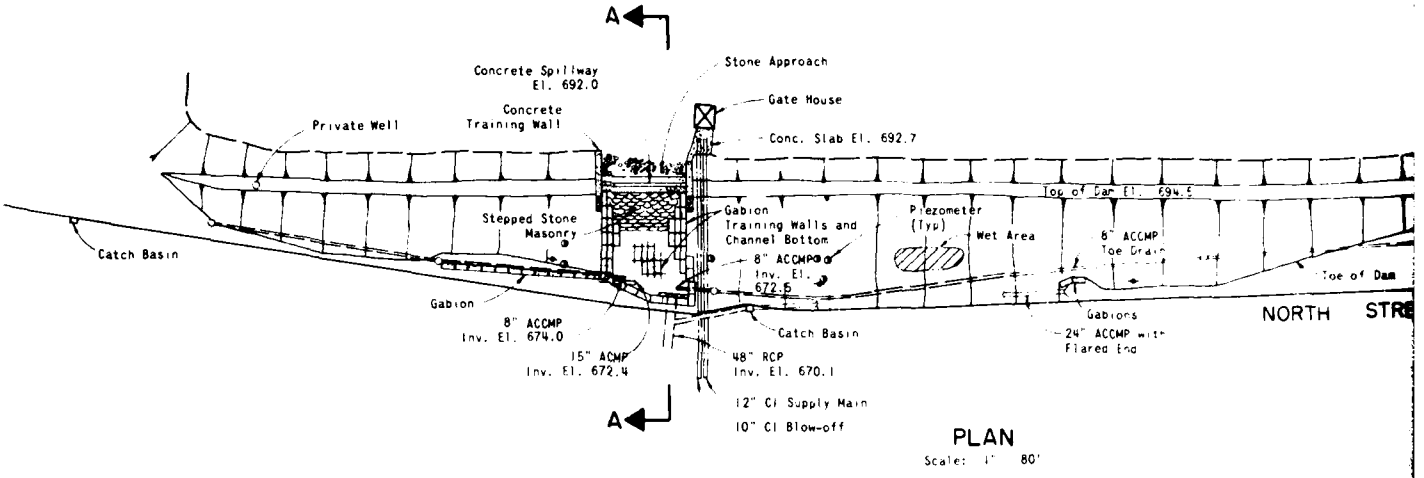
AREA EVALUATED	CONDITIONS
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
A. APPROACH CHANNEL:	
GENERAL CONDITION	Good
LOOSE ROCK OVERHANGING CHANNEL	None
TREES OVERHANGING CHANNEL	None
FLOOR OF APPROACH CHANNEL	Lined with stone
B. WEIR AND TRAINING WALLS:	
GENERAL CONDITION OF CONCRETE	Good
RUST OR STAINING	None observed
SPALLING	Some spalling of upstream training wall below water.
ANY VISIBLE REINFORCING	None observed
ANY SEEPAGE OR EFFLORESCENCE	Possible seepage at right end of weir between concrete and stone masonry.
DRAIN HOLES	N/A
C. DISCHARGE CHANNEL:	
GENERAL CONDITION	Fair; flows into 48" RCP culvert, then to natural streambed
LOOSE ROCK OVERHANGING CHANNEL	Some loose rock on channel slopes.
TREES OVERHANGING CHANNEL	Some trees overhanging channel.
FLOOR OF CHANNEL	Gravel and cobbles
OTHER OBSTRUCTIONS	Remains of small dam several hundred feet downstream.

OTHER: Gabions placed inside training walls and downstream of spillway in good condition.

APPENDIX B

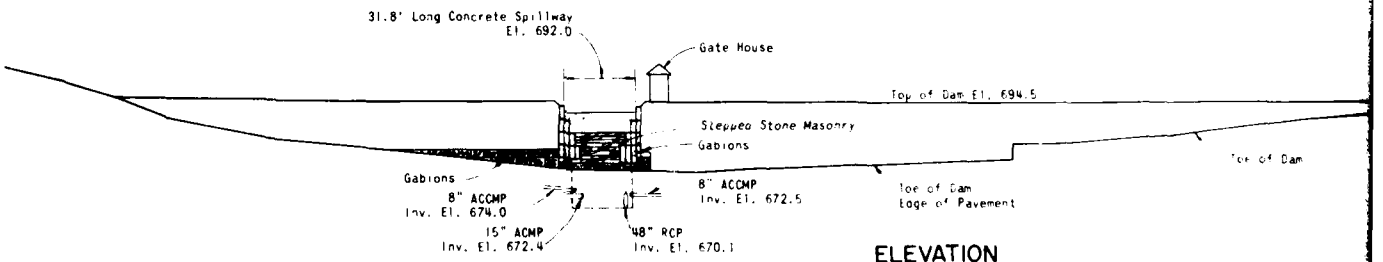
ENGINEERING DATA

PLYMOUTH RESERVOIR



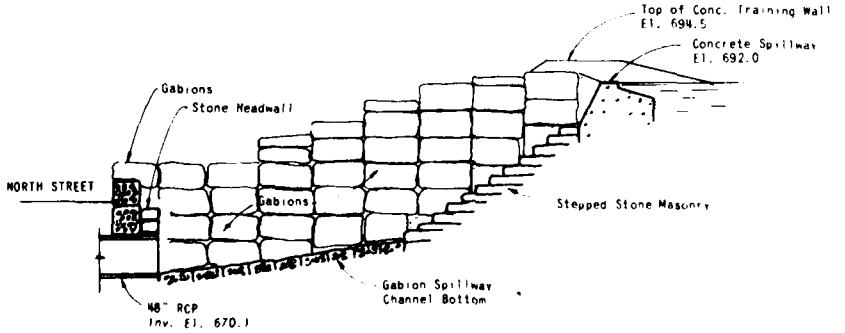
PLAN

Scale: 1" = 80'



ELEVATION

Scales: 1" = 80' Horiz.
1" = 40' Vert.

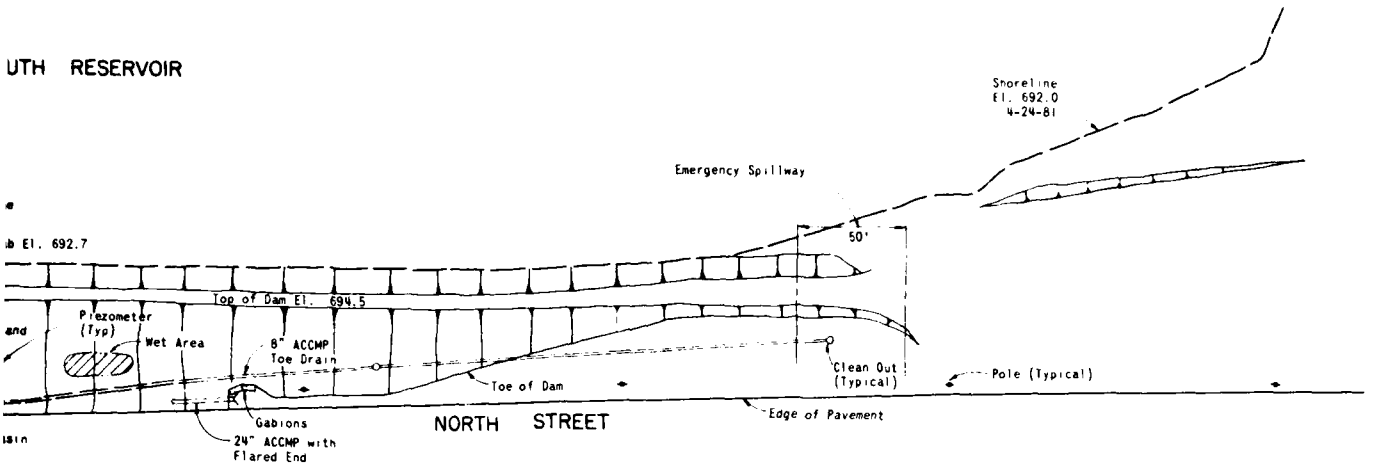


SECTION A-A

Scale: 1" = 20'

FIGURE 2

UTH RESERVOIR

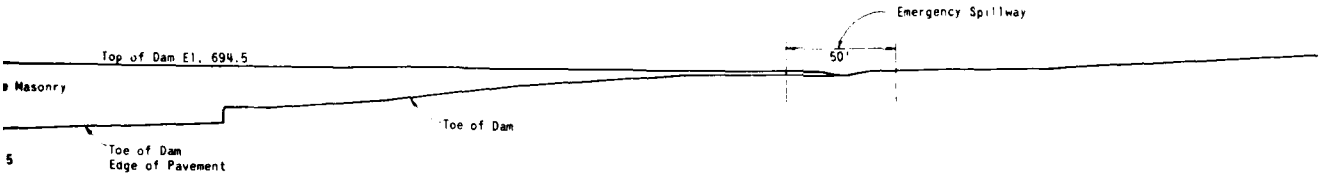


Main

ff

PLAN

Scale: 1" = 80'



ELEVATION

Scales: 1" = 80' Horiz.
1" = 40' Vert.

nc. Training Wall

ncrete Spillway
. 692.0

ROALD HAESTAD, INC *CONSULTING ENGINEERS* WATERBURY, CONNECTICUT			US ARMY ENGINEER DIV NEW ENGLAND *CORPS OF ENGINEERS* WALTHAM, MASS	
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS PLYMOUTH RESERVOIR				
DRAWN	CHECKED	APPROVED	SCALES AS NOTED	
JRS	RGL	RH	DATE MAY 1981	PAGE B-1

LIST OF REFERENCES

References listed below, as well as considerable additional correspondence and construction photographs, are located at the Connecticut Water Company, 93 West Main Street, Clinton, Connecticut 06413, and the Department of Environmental Protection, Water and Related Resources Unit, State Office Building, Hartford, Connecticut 06115.

1. Plans and Specifications, Plymouth Reservoir Dam Repairs, by Metcalf and Eddy, Inc., July 21, 1977.

2. Memo from J. R. McQueen, Thomaston Reservoir Gatehouse, September 7, 1977.

3. Flood routing computations, Metcalf and Eddy, Inc., August 5, 1976.

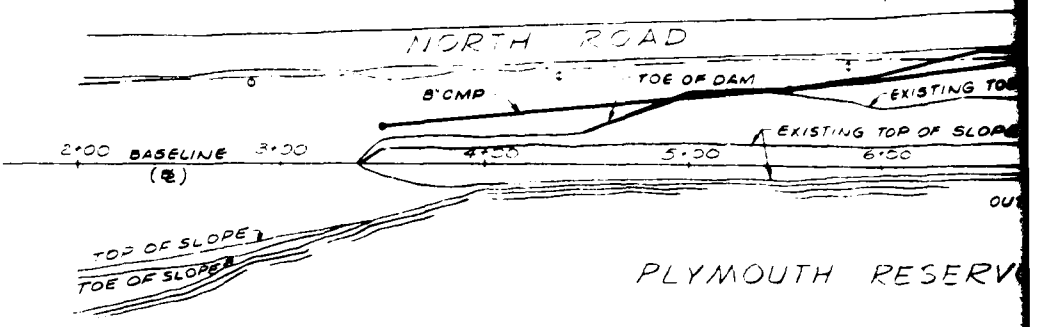
4. "Investigation of Seepage and General Condition of Plymouth Reservoir Dam", Letter Report to William F. Guillaume from Metcalf and Eddy, Inc., August 19, 1975.

5. Boring Logs, Associated Boring Company, Inc., Plymouth Reservoir, Plymouth Connecticut, June 9 through June 20, 1975.

6. Letter inspection report, Plymouth Reservoir, Plymouth, Connecticut, S. E. Minor and Company, Inc., to Victor Galgowski, Superintendent of Dam Maintenance, Water and Related Resources, July 15, 1974.

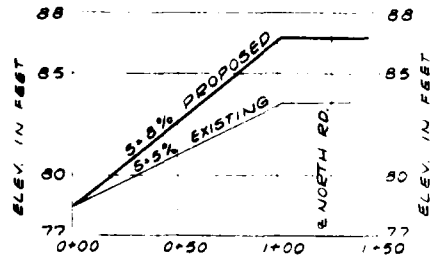
7. Stage-Capacity Curve, Thomaston Reservoir, The Henry Souther Engineering Company, December 1948.

8. Sketches, Dam and Gatehouse, The Henry Souther Engineer Company, December 6, 1932.



PLAN OF PLYMOUTH RESER

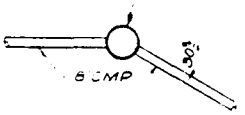
SCALE 1" = 40



STATION ALONG BLAKEMAN ROAD

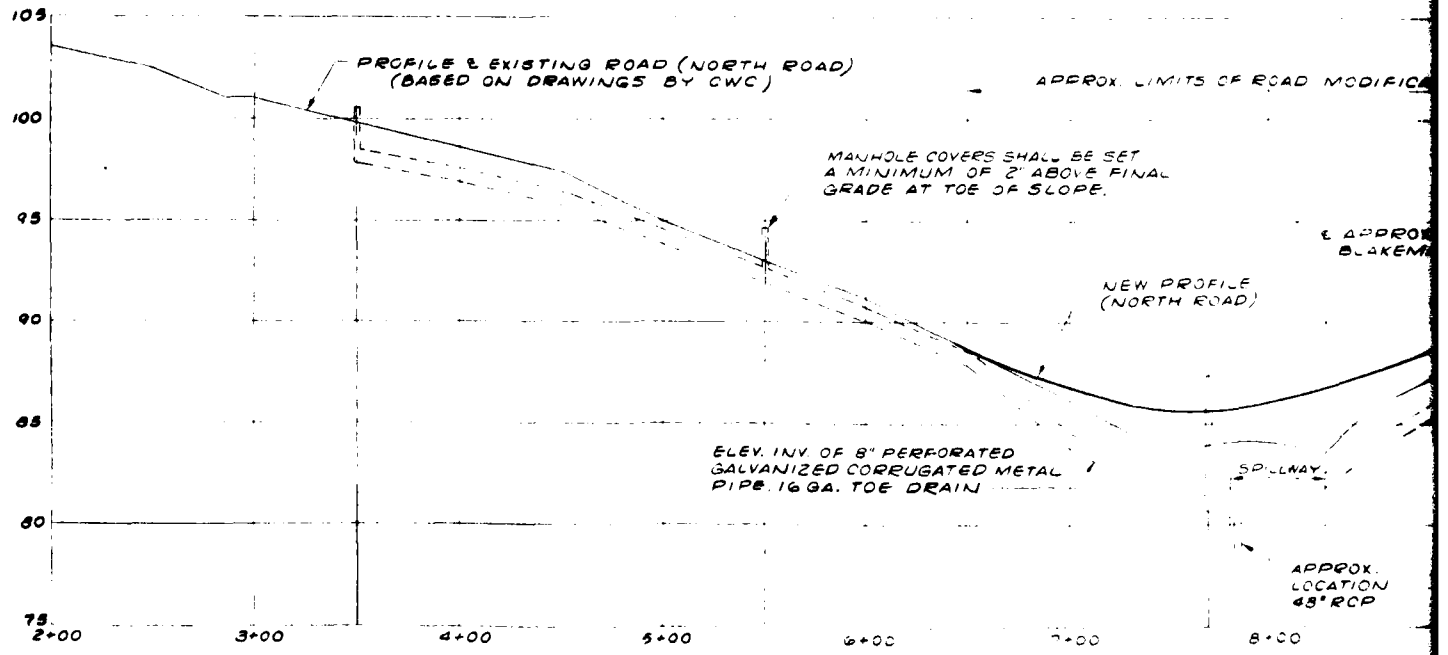
SCALE : HOR. 1"=40'
VERT. 1"=4'

CLEANOUT SHALL CONSIST OF A 30" DIA. CORRUGATED METAL MANHOLE WITH BOLTED COVER AT FINAL GRADE (TYP.)



DETAIL A @ STA. 7+69

NO SCALE



STATION ALONG BASE LINE OF DAM

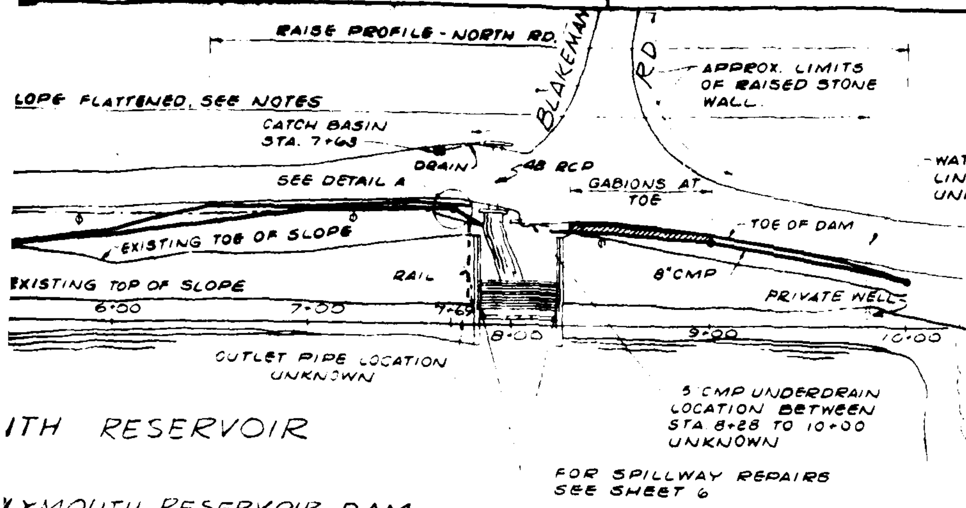
SCALE : HOR. 1"=40'
VERT. 1"=4'

NUMBER	DATE	MADE BY	CHECKED BY	DESCRIPTION
				REVISIONS

DRAWN BY W.E. Whitmore
DEPT CHECK
PROJ CHECK

METCALF & EDDY
BOSTON NEW YORK

REG PROF ENGR



ITH RESERVOIR

LYMOUTH RESERVOIR DAM

SCALE: 1" = 40'

LEGEND

● CLEANOUT

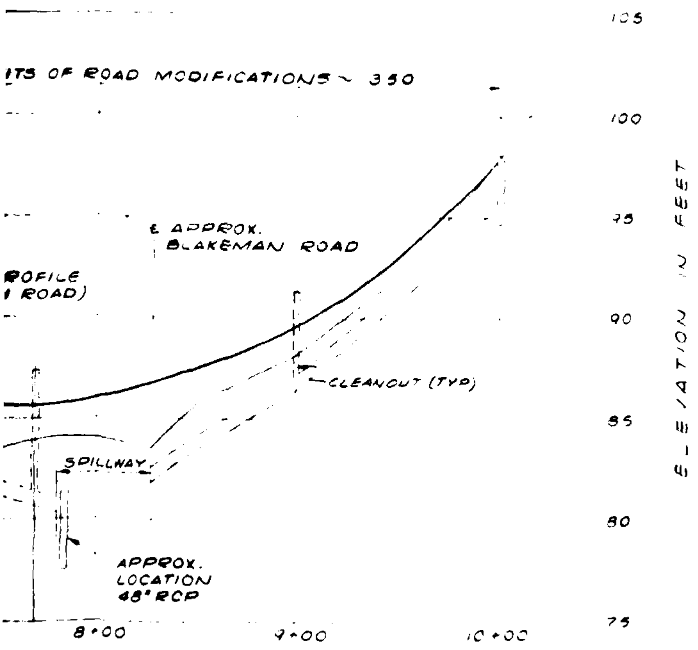
TELEPHONE POLE

NOTES:

1. THE RESERVOIR SHALL BE LOWERED TO EL. +96 (MAX.) AT LEAST TWO WEEKS PRIOR TO THE START OF CONSTRUCTION.
2. UTILITY LINE SHALL BE SUPPORTED PRIOR TO CONSTRUCTION.
3. RAISED ROAD SLOPES 1/8"/FT. AWAY FROM DAM.
4. 6" MINIMUM COMPACTED THICKNESS OF CONCRETE SAND PLACED ABOVE ALL AREAS STRIPPED OF TOP SOIL. AREAS OF GREATER THICKNESS SHOWN IN TYPICAL DETAILS.
5. THE REQUIRED PERCENT COMPACTION SHALL BE THE RATIO OF THE IN PLACE DRY DENSITY DETERMINED BY ASTM D1556 "SAND CONE METHOD" TO THE MAXIMUM DRY DENSITY DETERMINED BY ASTM D698 METHOD D "MOISTURE-DENSITY" RELATION OF SOILS USING 5.5 LB. RAMMER AND 12-INCH DROP. ALL MATERIALS SHALL BE COMPACTED TO 95 PERCENT STANDARD PROCTOR MAXIMUM DENSITY.
6. THE STONE WALL SHALL BE RAISED TO 1½-2 FT. ABOVE THE FINISHED ROADWAY SURFACE.
7. THE CONTRACTOR SHALL LOCATE AND DETERMINE THE DEPTHS OF ALL PIPES (OUTLET, UNDERDRAIN, WATER SUPPLY) THAT MAY BE ENCOUNTERED DURING CONSTRUCTION PRIOR TO BEGINNING WORK. SEE CONSTRUCTION SEQUENCE.
8. PROPOSED FINAL SLOPES SHALL BE IN ACCORDANCE WITH THE FOLLOWING TABLE:

STATION	PROPOSED SLOPE HOR.	PROPOSED SLOPE VERT.	REFERENCE POINT DIST. FROM ℄	REFERENCE POINT EL.
3+50	EXISTING		–	
4+00	EXISTING		–	
4+50	EXISTING		–	
5+00	5	1	10	101.5
5+50	4	1	10	101.5
6+00	4	1	10	101.0
6+50	3¾	1	10	101.0
7+00 TO 9+80	3¾	1	10	101.0
10+00	EXISTING		–	

9. ALL PAVEMENT SECTIONS TO BE AS DESIGNED BY [illegible] TO MEET TOWN OF PLYMOUTH REQUIREMENTS.
10. BORING LOGS AND MATERIAL TEST RESULTS WILL BE AVAILABLE FOR INSPECTION AT THE THOMASTON WATER CO. OFFICE.
11. REMOVE HANDRAIL FOR WORK ON THE EMBANKMENT AND THEN REPLACE AS REQUIRED.
12. CLEANOUT [illegible] BE PLACED IN [illegible] OF CONCRETE SAND BOTTOM AND [illegible] OF COARSE AGGREGATE.
13. UNLESS OTHERWISE DIRECTED BY THE ENGINEER, ALL MATERIAL SHALL BE PLACED IN 6 INCH MAXIMUM LOOSE LIFTS.



OF DAM

NOT TO SCALE

STATION	℄ TOP OF PAVEMENT (ROADWAY)	INVERT TOE DRAIN	HORIZONTAL DISTANCE TOE DRAIN FROM BASE LINE OF DAM
3+50		[illegible]	[illegible]
4+00	–	96.[illegible]	[illegible]
4+50	–	[illegible]	[illegible]
5+00	–	[illegible]	[illegible]
5+50	–	[illegible]	[illegible]
6+00	–	90.0	44
6+50	88.7	87.8	49
7+00	86.7	83.8	5[illegible]
7+50	85.7	[illegible]	[illegible]
7+69	85.[illegible]	[illegible]	[illegible].5
7+80	85.[illegible]	8[illegible]	[illegible].5
8+00	86.0	–	–
8+28	86.[illegible]	82.8	4[illegible]
8+50	87.[illegible]	83.[illegible]	4[illegible]
9+00	89.[illegible]	86.[illegible]	4[illegible]
9+50	93.0	90.8	[illegible]
9+80	95.7	93.[illegible]	26
10+00		94.7	29.5

METCALF & EDDY, INC. / ENGINEERS
BOSTON · NEW YORK · PALO ALTO · CHICAGO

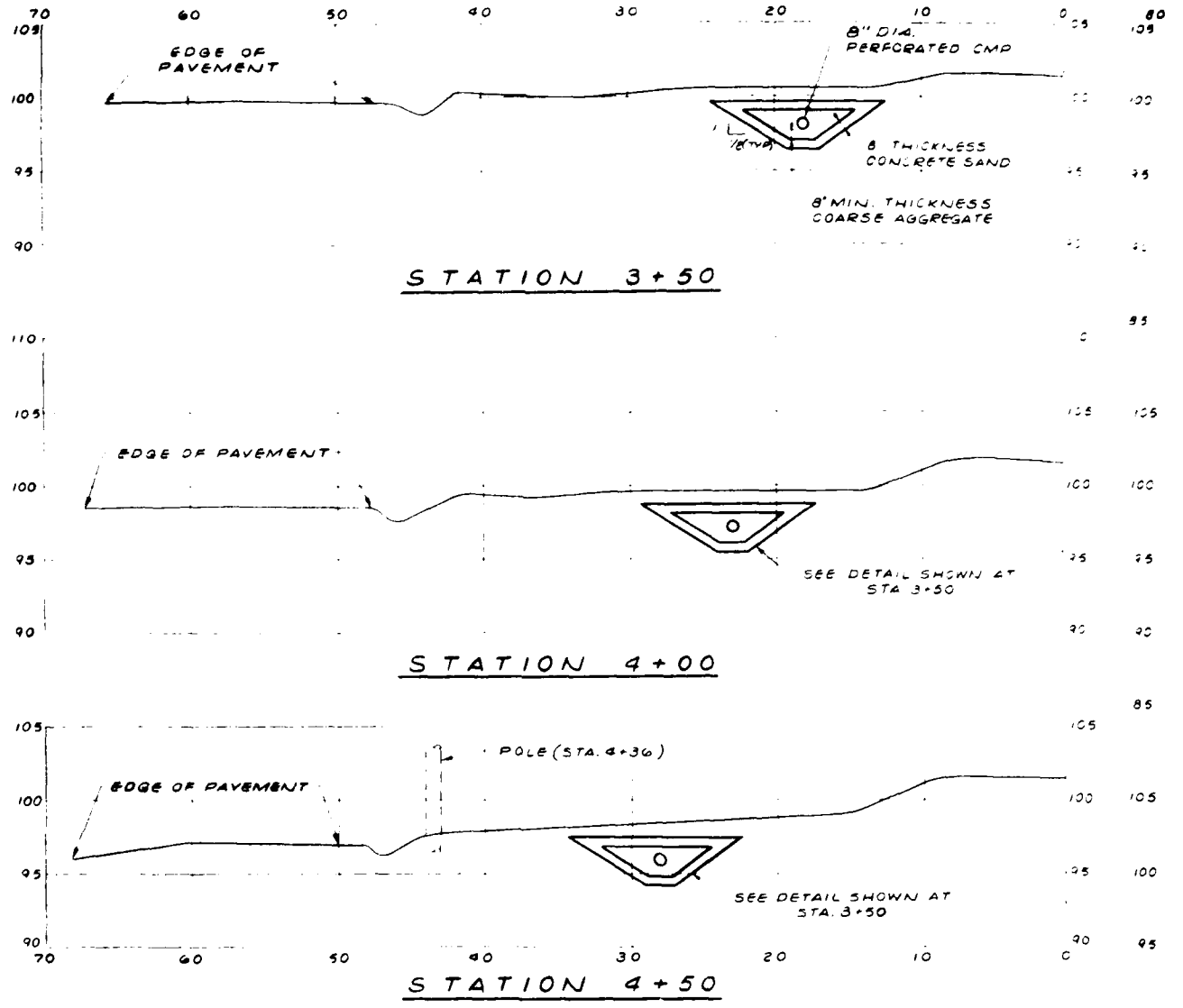
7/21/77
7/21/77

SCALE: AS SHOWN

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

TOWN OF PLYMOUTH, CONNECTICUT
THOMASTON WATER COMPANY
PLYMOUTH RESERVOIR DAM REPAIRS
PLANS AND ROADWAY PROFILE

JOB 4172
FILE NO. 10-89397-1 TH 39
SHEET 1 OF 6



NUMBER	DATE	MADE BY	CHECKED BY	DESCRIPTION

REVISIONS

DRAWN BY

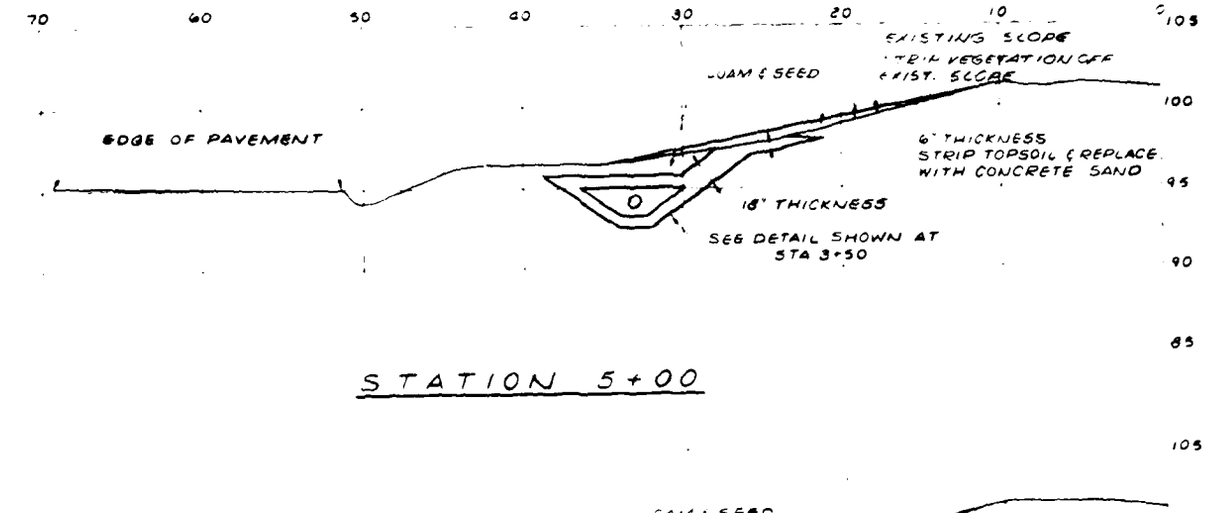
DEPT. CHECK

PROJ. CHECK

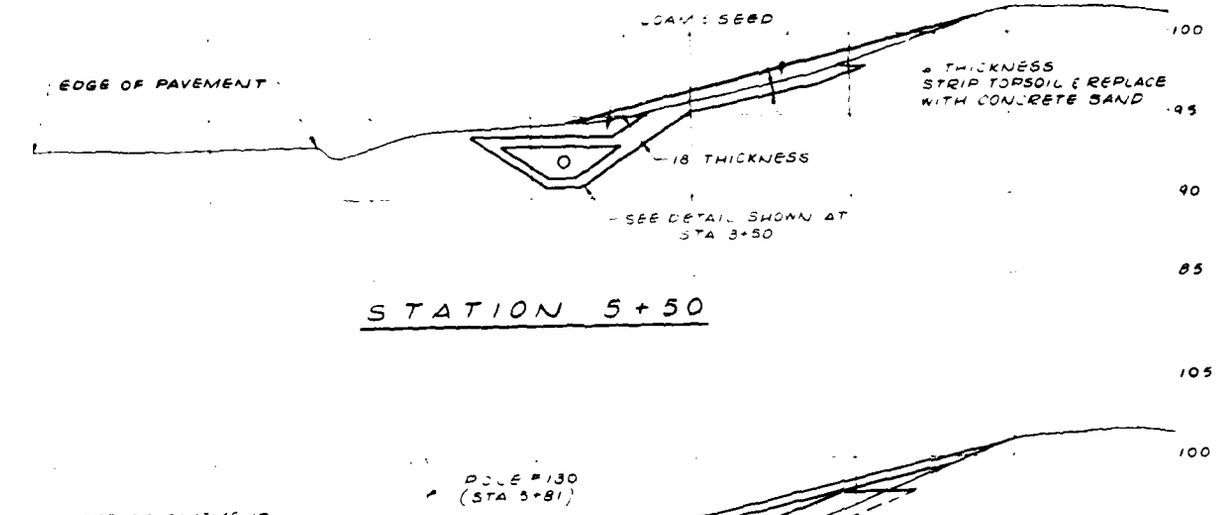
METCALF

REG. PROF. ENGR.

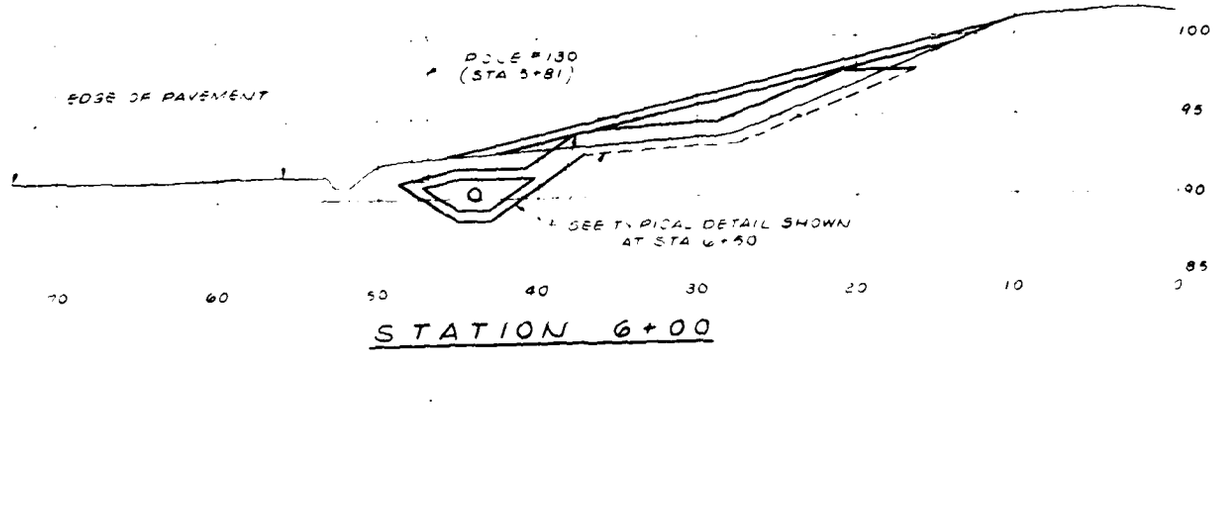
REG PROF ENGR



STATION 5+00



STATION 5+50

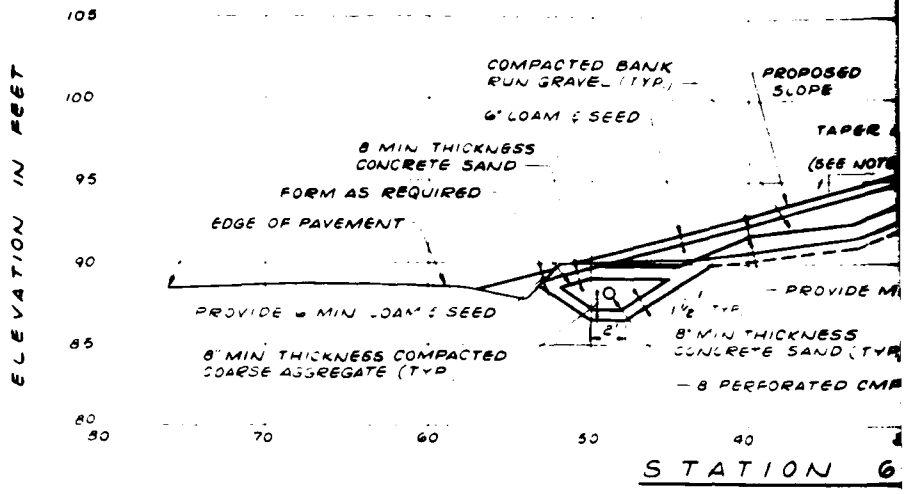


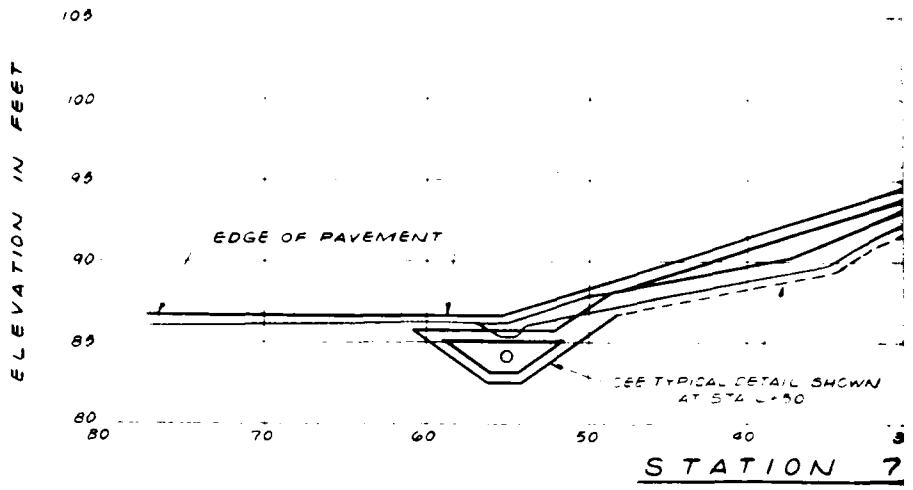
STATION 6+00

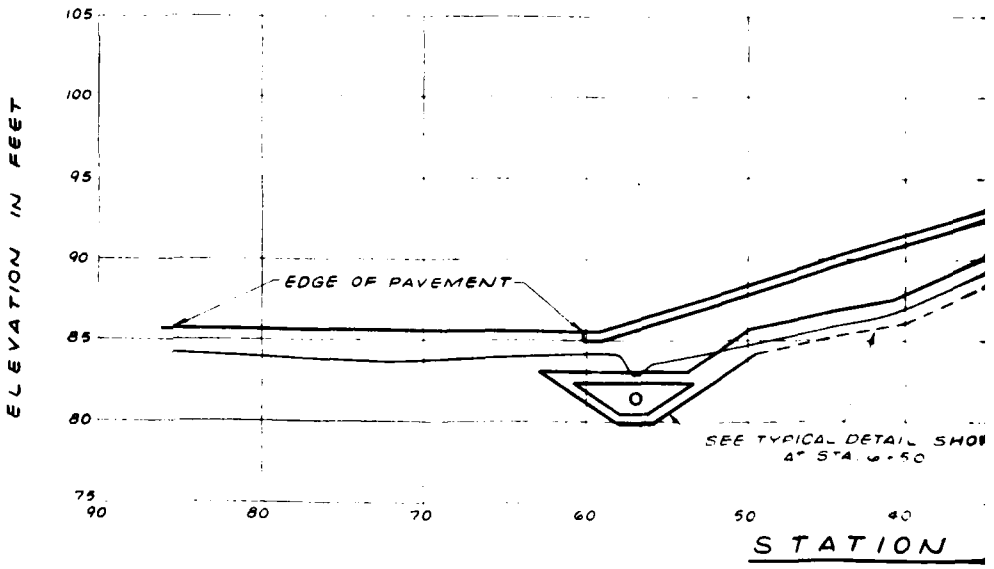
NOT TO SCALE

METCALF & EDDY, INC. / ENGINEERS BOSTON / NEW YORK / PALO ALTO / CHICAGO 7/21/77 DATE DATE	SCALE: 1" = 5'-0" UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION	TOWN OF PLYMOUTH, CONNECTICUT THOMASTON WATER COMPANY PLYMOUTH RESERVOIR DAM REPAIRS CROSS SECTIONS	JOB W177 FILE NO. H-69386-1 TH 89 SHEET 2 OF 6

B-4







NUMBER	DATE	MADE BY	CHECKED BY	DESCRIPTION

REVISIONS

DRAWN BY

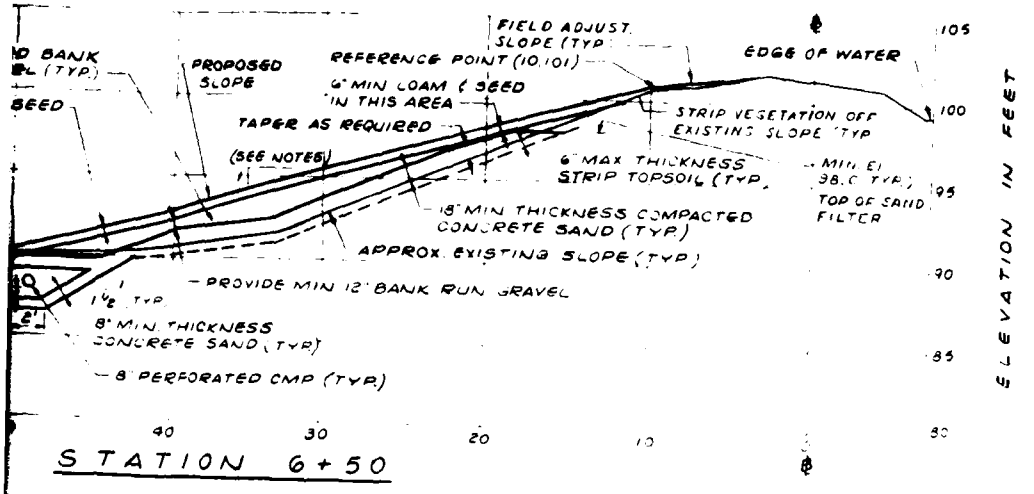
DEPT. CHECK

PROJ. CHECK

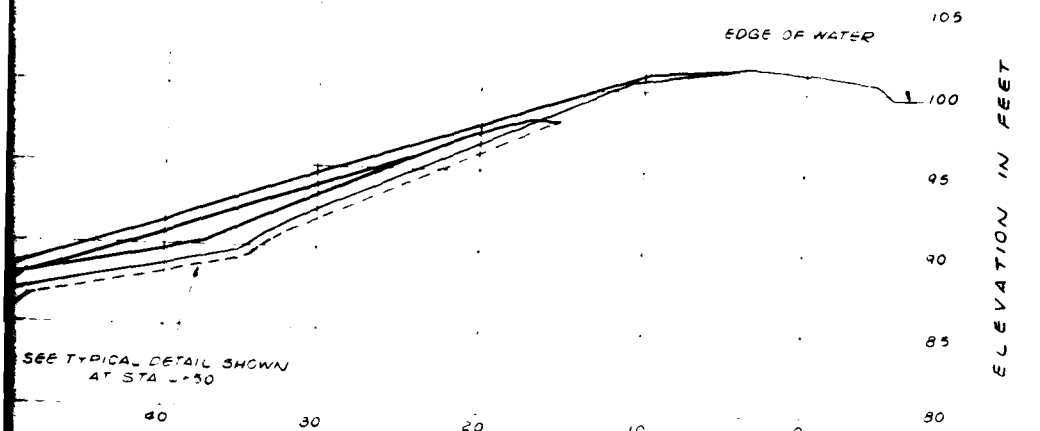
METCALF & EDDY

BOSTON NEW YORK

REG. PROF. ENGR.



STATION 6+50



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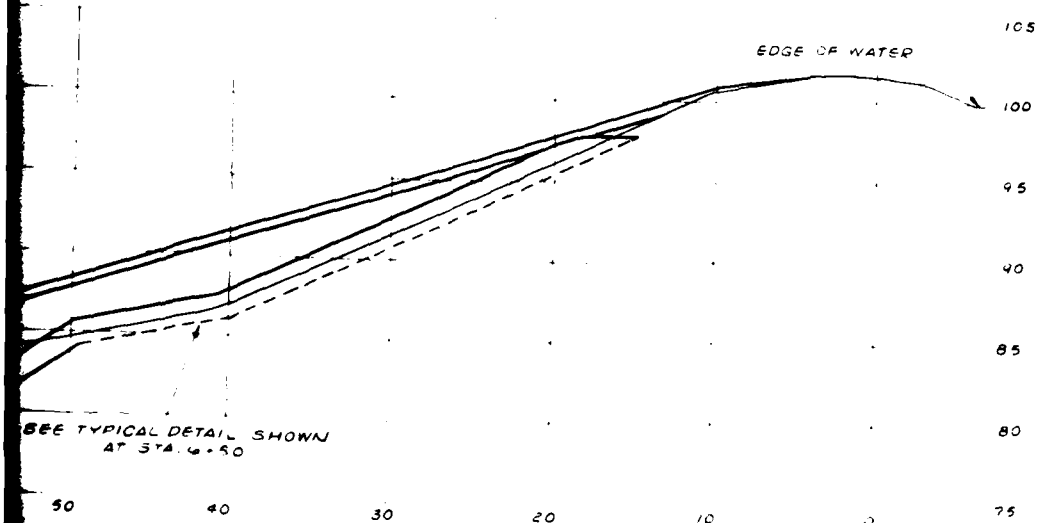
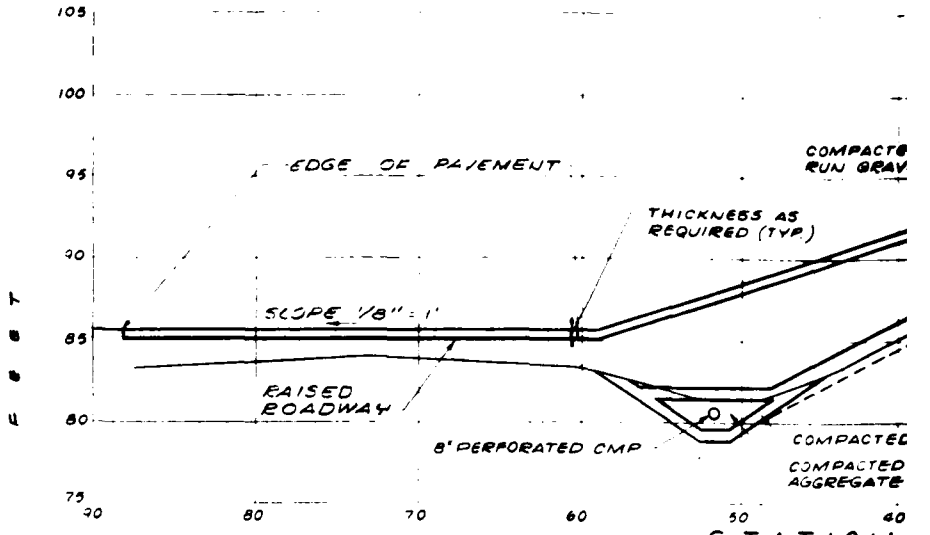
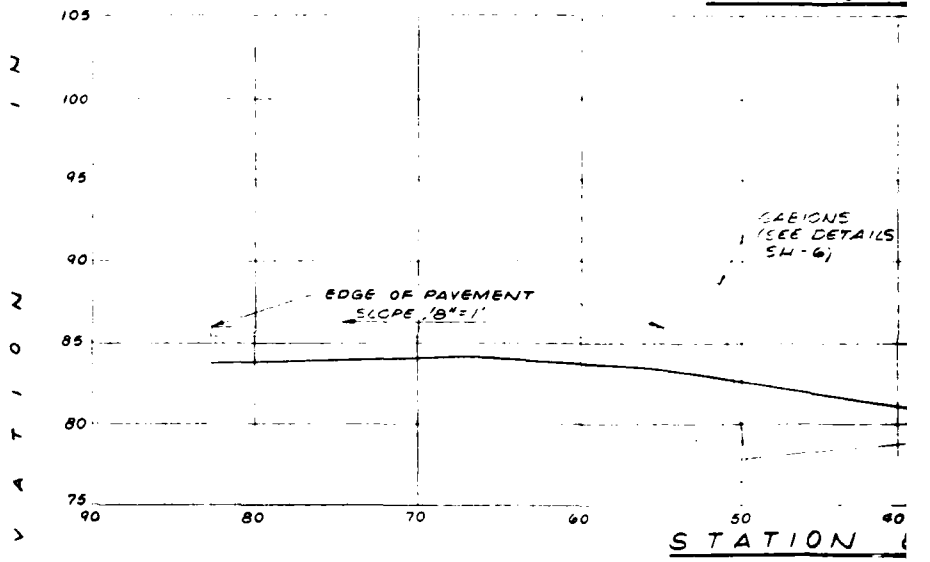


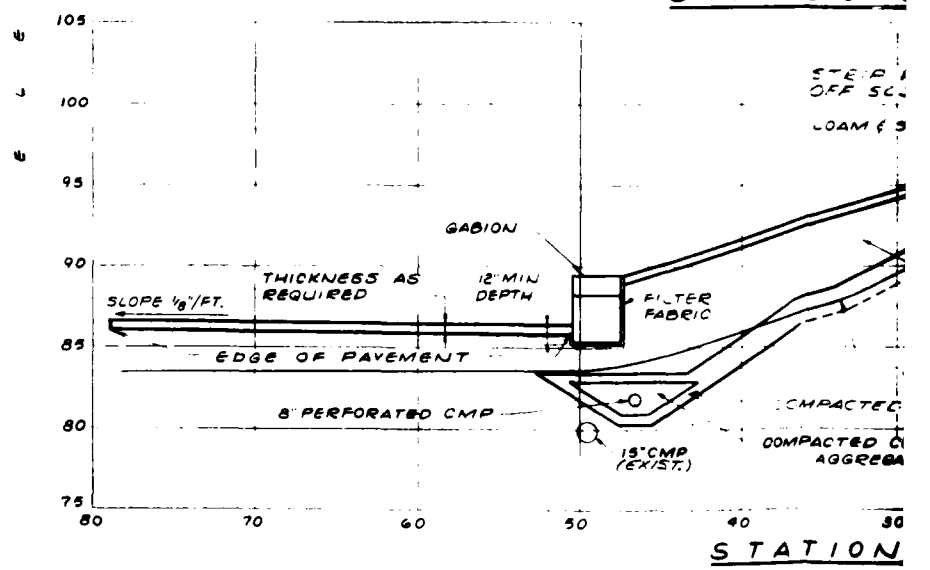
STATION 7+50

NOT TO SCALE

METCALF & EDDY, INC. / ENGINEERS BOSTON / NEW YORK / PALO ALTO / CHICAGO	SCALE: 1" = 5'-0"	TOWN OF PLYMOUTH, CONNECTICUT THOMASTON WATER COMPANY PLYMOUTH RESERVOIR DAM REPAIRS CROSS SECTIONS	JOB M177 FILE NO. H-69399-1 TH 39 CONTRACT 77-1 SHEET 3 OF 6
DES. ENGR. 7/21/77 DATE	UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION		
CHKD. 7/21/77 DATE			







NUMBER	DATE	MADE BY	CHECKED BY	DESCRIPTION

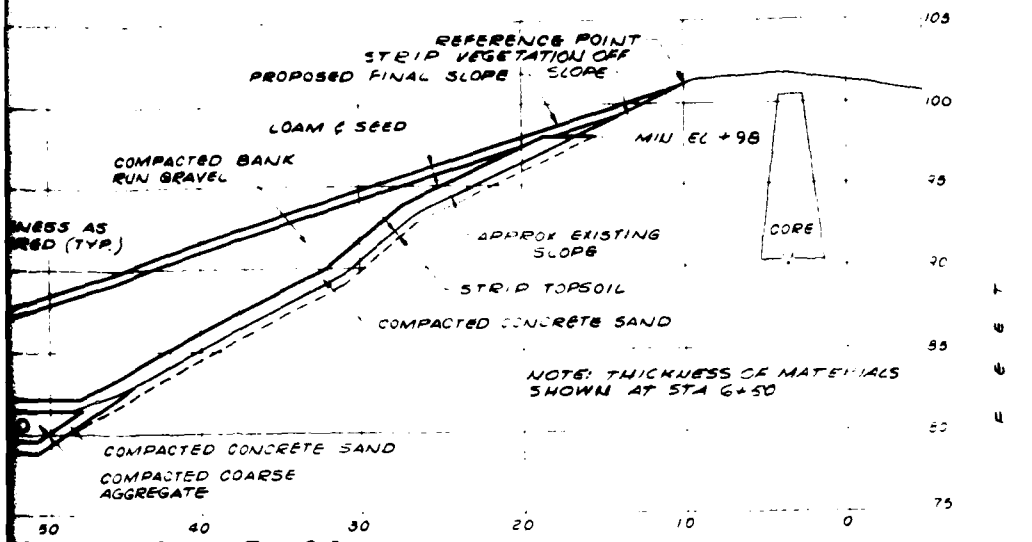
REVISIONS

DRAWN BY

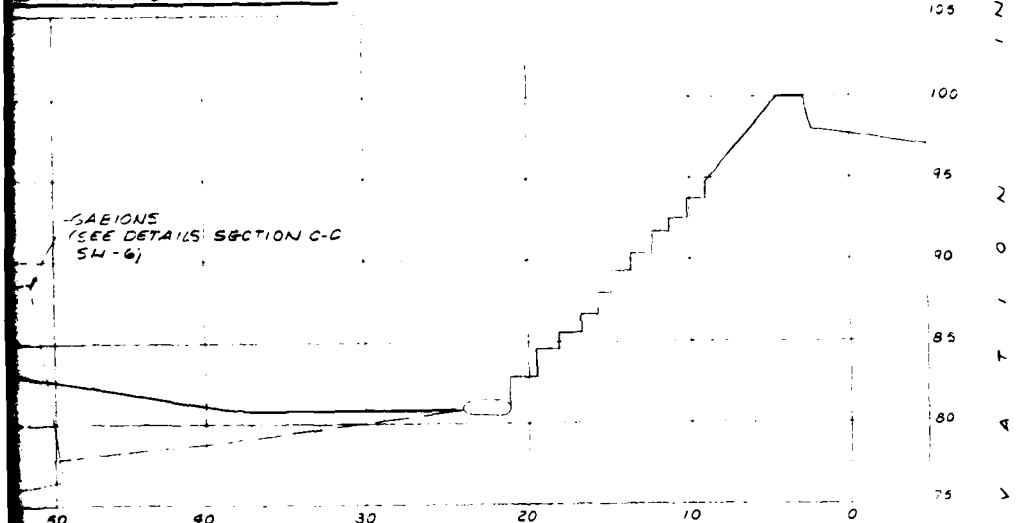
DEPT. CHECK

PROJ. CHECK

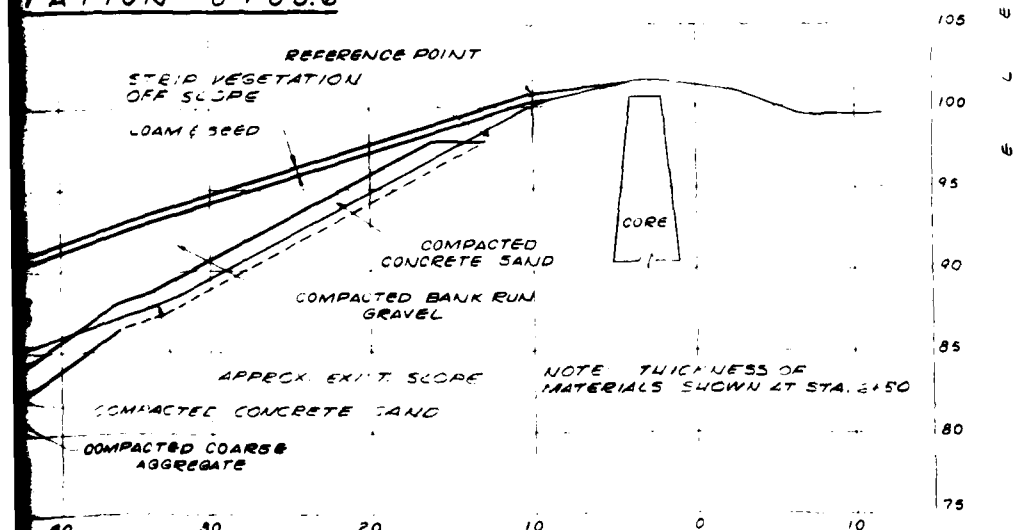
M&E METCALF



STATION 7+80



STATION 8+03.6



STATION 8+28

NOT TO SCALE

METCALF & EDDY, INC. / ENGINEERS
BOSTON / NEW YORK / PALO ALTO / CHICAGO

7/8/77
7/21/77

SCALE: 1" = 10"

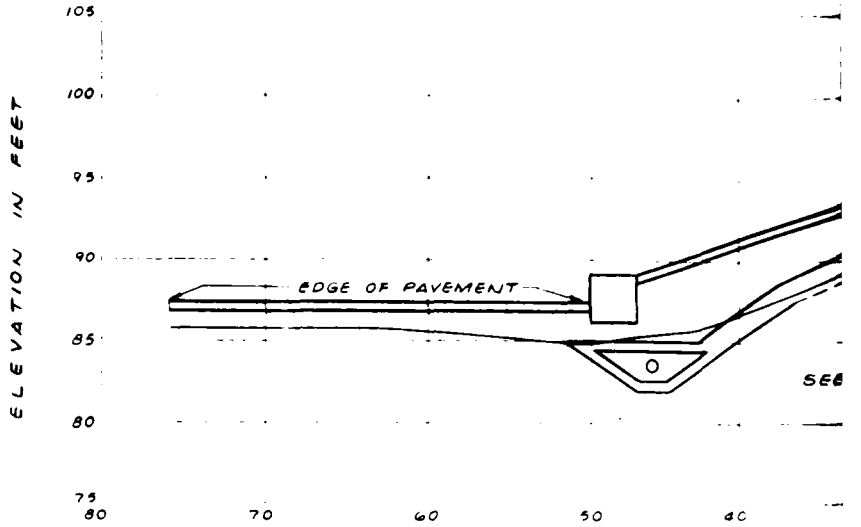
UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

TOWN OF PLYMOUTH, CONNECTICUT
THOMASTON WATER COMPANY

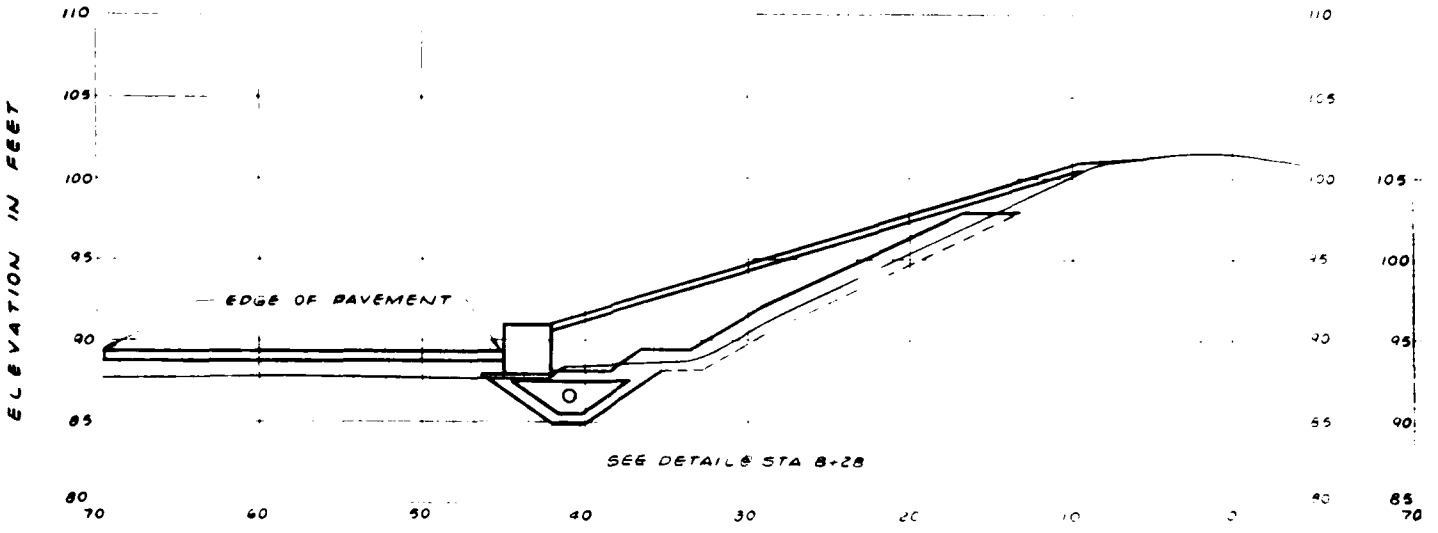
PLYMOUTH RESERVOIR DAM REPAIRS

CROSS SECTIONS

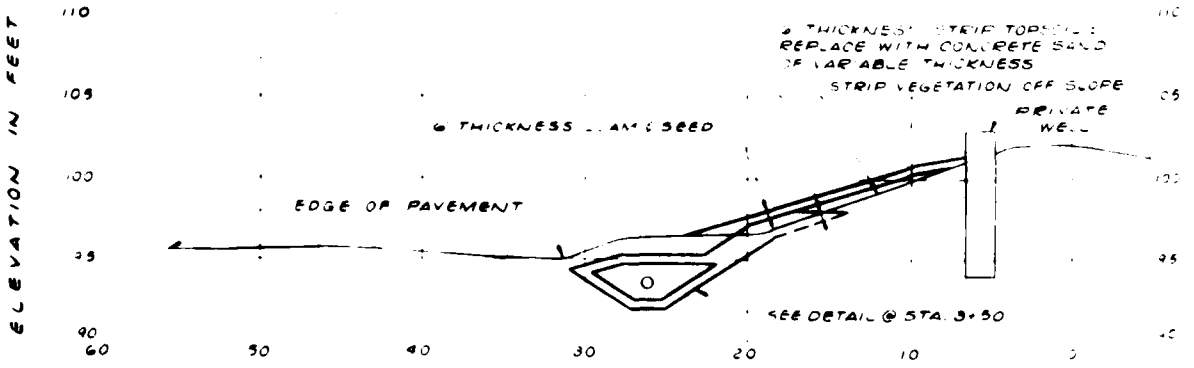
JOB 4177
FILE NO. H-69400-1
TH 39
SHEET 4 OF 8



STATION



STATION 9+00



STATION 9+80

NUMBER	DATE	MADE BY	CHECKED BY	DESCRIPTION

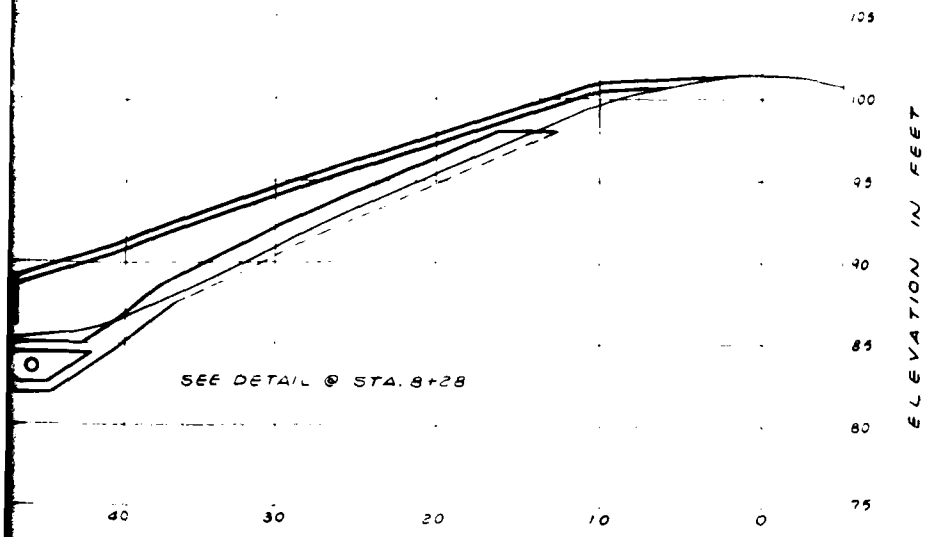
REVISIONS

DRAWN BY

DEPT. CHECK

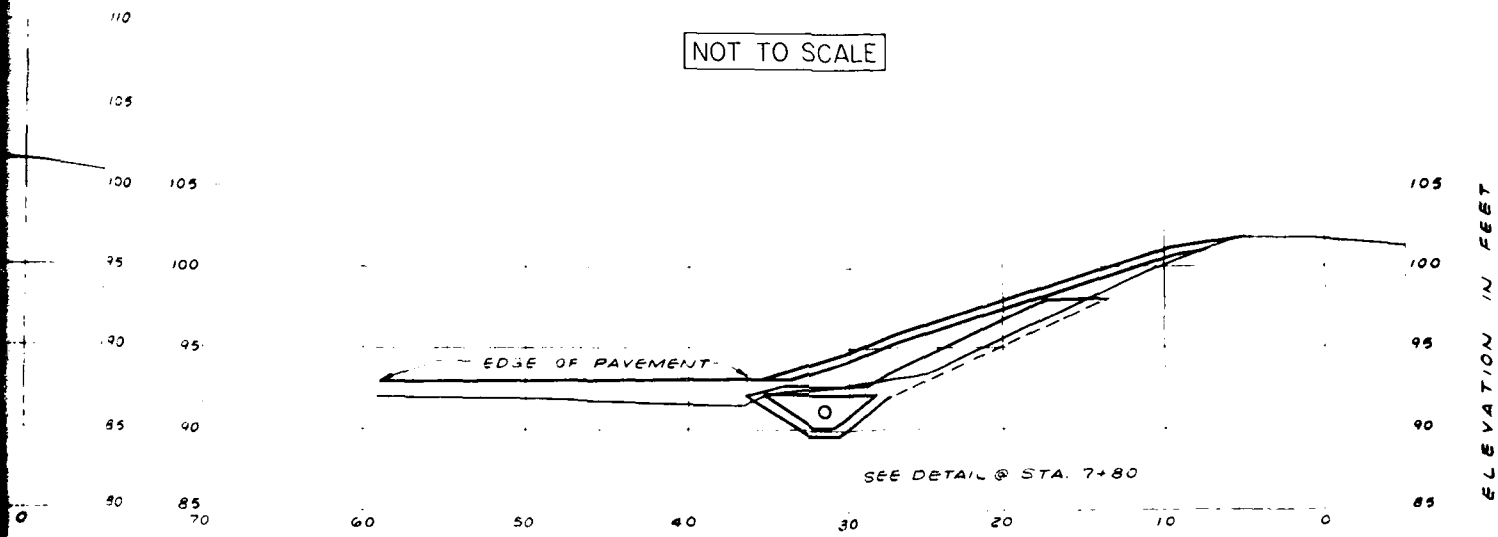
PROJ. CHECK

METCALF

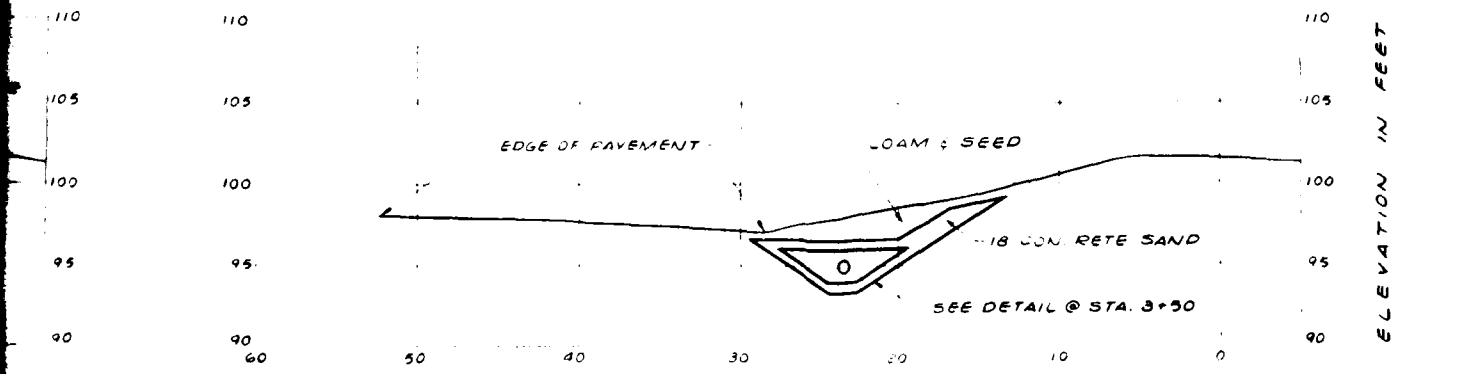


TATION 8 + 50

NOT TO SCALE

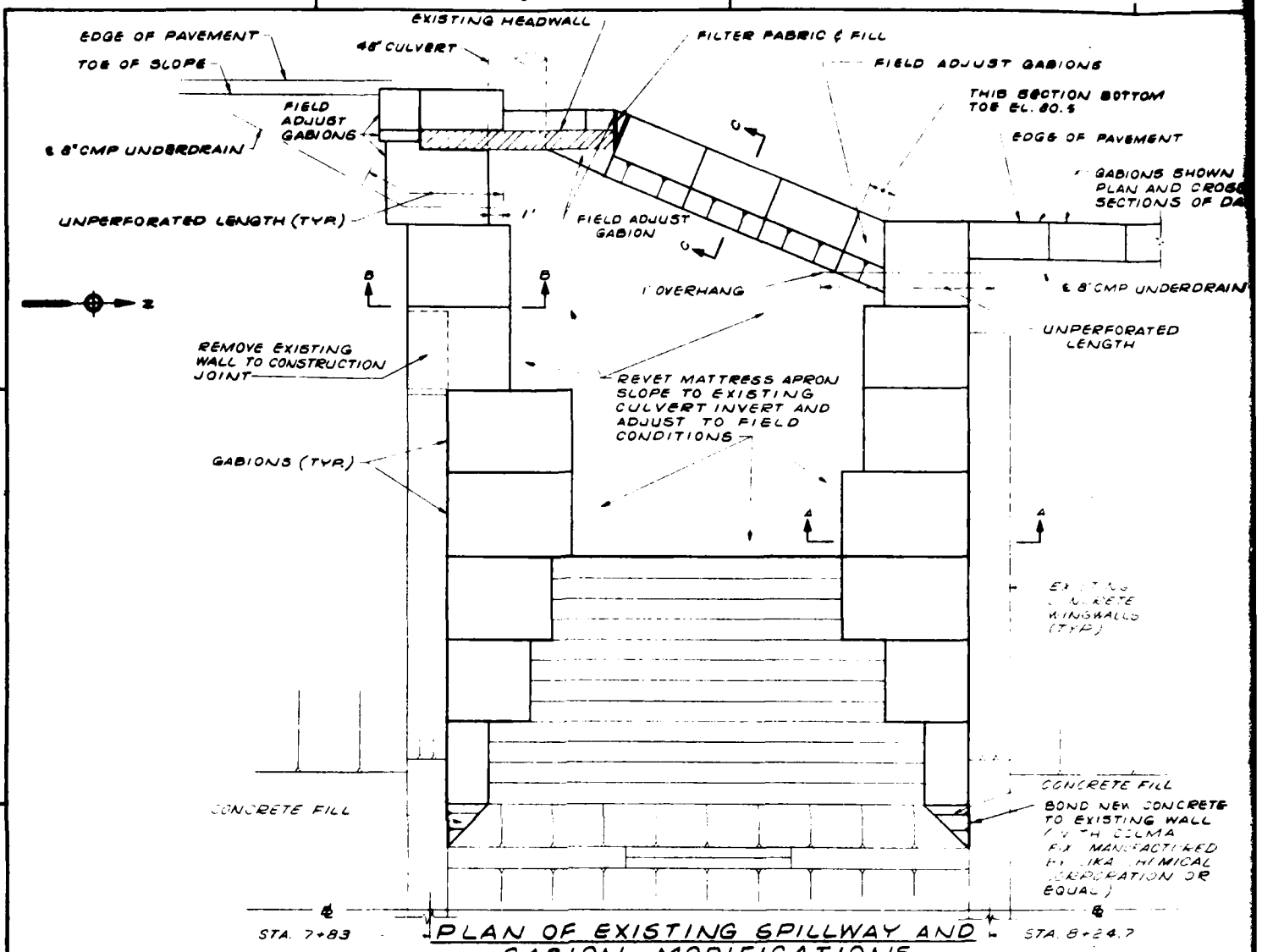


STATION 9 + 50



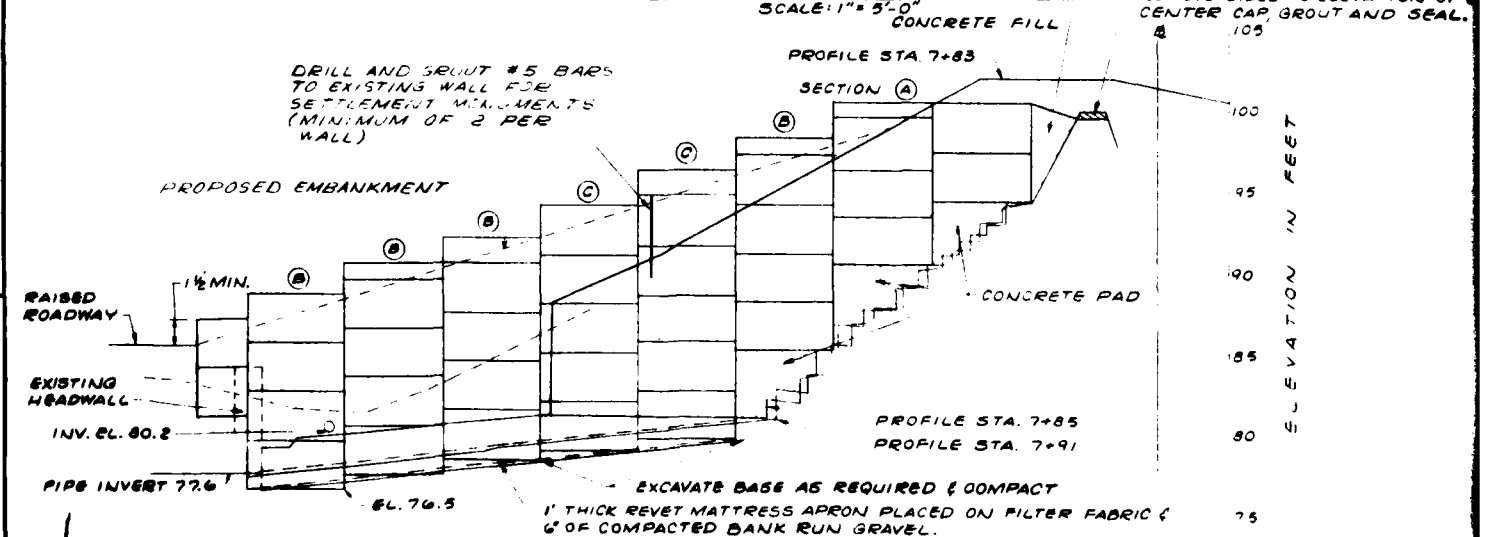
STATION 10 + 00

METCALF & EDDY, INC. / ENGINEERS BOSTON NEW YORK PALO ALTO CHICAGO 12/21/77 DATE 2/2/77 DATE	SCALE: 1" = 5'-0" UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION	TOWN OF PLYMOUTH, CONNECTICUT THOMASTON WATER COMPANY PLYMOUTH RESERVOIR DAM REPAIRS CROSS SECTIONS	JOB 4177 FILE NO W-69401-1 SHEET 5 OF 6



PLAN OF EXISTING SPILLWAY AND GABION MODIFICATIONS

SCALE: 1" = 5'-0"



SOUTH SPILLWAY WALL PROFILE

SCALE: 1" = 5'-0"

NUMBER	DATE	MADE BY	CHECKED BY	DESCRIPTION

REVISIONS

DRAWN BY W. C. Whitemore

DEPT CHECK

PROJ CHECK

METCALF & EDDY

BABIONS

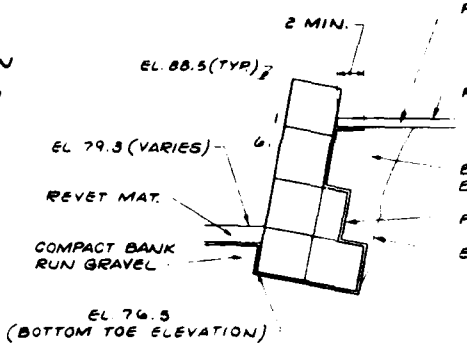
SECTION BOTTOM
L. 80.5

DGE OF PAVEMENT

GABIONS SHOWN ON PLAN AND CROSS SECTIONS OF DAM

6" CMP UNDERDRAIN

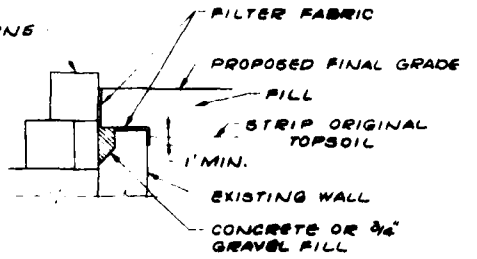
UNPERFORATED LENGTH



STA. 8+06 (TYP.)

SECTION C-C

SCALE: 1"=5'

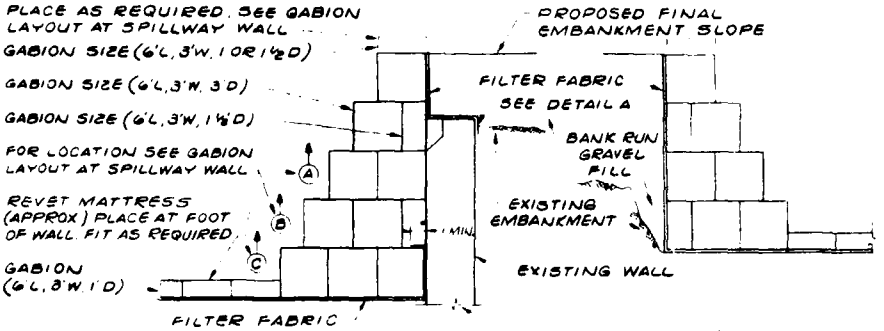


DETAIL A

NO SCALE

A

EXISTING CONCRETE WINGWALLS (TYP.)



NOT TO SCALE

CONCRETE FILL

BOND NEW CONCRETE TO EXISTING WALL (WITH SIKA FIX MANUFACTURED BY SIKA CHEMICAL CORPORATION OR EQUAL)

SECTION A-A

TYPICAL SECTION AT EXISTING WALL

NO SCALE

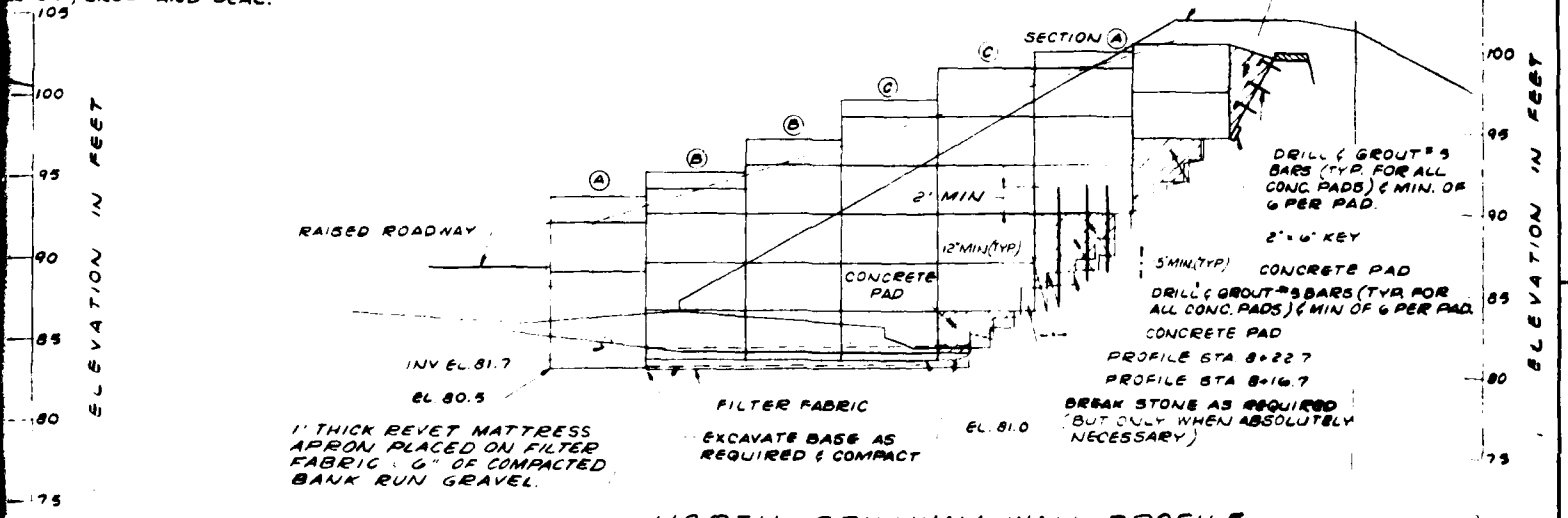
SECTION B-B

TYPICAL SECTION AT NEW WALL

NO SCALE

STA. 8+24.7

SIDES TO ELEVATION OF EXISTING CAP, GROUT AND SEAL.



NORTH SPILLWAY WALL PROFILE

SCALE: 1"=5'-0"

METCALF & EDDY, INC. / ENGINEERS BOSTON / NEW YORK / PALO ALTO / CHICAGO	SCALE: AS SHOWN	TOWN OF PLYMOUTH, CONNECTICUT THOMASTON WATER COMPANY PLYMOUTH RESERVOIR DAM REPAIRS GABION DETAILS	JOB 4177. FILE NO. TH 39 SHEET 6 OF 9
7/6/77 DATE 7/21/77 DATE	UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION		

CC: W.T. DUNN

VISUAL INSPECTION CHECKLIST FOR DAMS

The Connecticut Water Company

Dam Name: PLYMOUTH RESERVOIR Inspection Date: APRIL 28, 1981

Present at Inspection: R. BAILLARGEON, R. HARSTAD, R. LITKE, D. SMITH, K. KELLS

Reservoir Level: FULL

General condition of slopes or dam faces: GOOD

Any evidence of erosion on upstream face? NO

On downstream face? NO

Any unwanted tree growth? NO

Any animal burrows in slopes? NO

Any notable earth movements? NO

Any spongy spots or noticeable seepage? YES - 40' SOUTH OF HELCO POLE #131 AND 15' RT. APPROX 20' LONG X 8' WIDE AREA SATURATED TO SURFACE. NO WATER MOVING

Spillway condition: VERY GOOD

Spillway Obstructions: NONE

Tail Race Conditions: GOOD

Downstream obstructions or undermining of spillway or splash pad: NONE

Comments or recommendations:

(1) REPAIR 1 OBSERVATION WELL THAT HAS BEEN BROKEN AND IS STILL VISIBLE AT GROUND SURFACE. (AT TOP OF EMBANKMENT OPP. POLE #131. REPLACE CAP ON OB. 9

(2) CHECK WET AREA CAREFULLY AT NEXT MONTHLY INSPECTION. NOTE ANY CHANGES. LOOK FOR EVIDENCE OF ANY WATER MOVEMENT.

Prepared by: [signature] date 4/28/81

Reviewed by: date

Distribution: KWK

INTER OFFICE MEMO — THE CONECTICUT WATER COMPANY

SUBJECT: [illegible] Reservoir, Gatehouse

DATE: Sept. 7, 1977

FROM: J. R. McQueen

BLOOM	☐	MacKENZIE	☐
BURRILL	☐	SHAW	☐
CIARCIA	☐	STEWART	☐
DUNN	☒	TARNOWICZ	☐
GUILLAUME	☒		☐
KELLS	☐		☐
LAFLAMME	☐		☐

On August 29, 1977 Bill Dunn reported small fish about 1/8" in diameter showing up at the Altair Company meter and also at the treated tap at the chlorination station. Roland reported many small minnows in and around the gatehouse with some downstream of the last screen. Advised chlorination with HTH around gatehouse and at intake levels to drive fish away and to remove fish in gate house with dip net if possible. I examined the screen system the 30th with Bill and Roland. Chlorination seemed to be keeping most of the fish away, but a few were still present in the gate house. The first two sets of screens, one coarse and one fine, were not down all the way. Reason unknown. The third set, also fine, appeared down all the way, but the mesh size, approximately 1/6", would still allow the small minnows to go through. Bill didn't want to remove the screens at this time for fear of not being able to get any of the three back into place thus making the situation worse than it was. I agreed. I scheduled a diver for Sunday, Sept. 4, (when we knew there would be a reverse flow from the well) to do whatever was required to get the screens back into their full closed positions. Also asked Bill to pick up enough vinyl or fiberglass window screen to cover one set of fine screens as well. We removed all screens on the 4th, cleaned and installed the window screen on the third set. The diver inspected the exterior and the interior of the gate house. The attached sketches are my interpretation of the diver's observations. In general, the diver (Ron Shvonski) found the gate house in sound structural condition with only slight deterioration of the masonry above the water line. The bottom of the gate house contained a large amount of silt and fine gravel (0.5 to 1 mm) that prevented the screens from closing. Most of this material was removed so that all screens could be properly reinstalled. The coarse set will not be pulled routinely in the hope it will act as a gravel stop for the other two sets of screens. The remaining screens will be examined weekly. The minnows should be large enough in a few weeks so they won't be able to get through even the first set of screens. This should eliminate the fish problem at least for the time being.

Other problems and questions that still remain are as follows:

1.) The channel approaching the upper intake is lined with fine sand and gravels similar to that found inside the gate house. Entrance velocities are apparently great enough to sweep this material into the structure and accumulate

on the bottom. This condition can be expected to continue.

2.) The lower intake with centerline approximately 20 feet below spillway is completely plugged with silt and gravel. The valve position is unknown. The center intake approximately 15 feet below spillway is a crack open. The upper intake approximately 9 feet below spillway is wide open. This valve is believed to have been last operated by W.N.M. at the time the Company was purchased. All valves are believed to be 8" MIS hub type gates with operating rods extended through the floor and wheels attached. I'm afraid to operate any of them.

3.) There is a single 8" outlet pipe located approximately 20 feet below spillway. The diver confirmed a reverse flow here at a time when we knew well water was reaching the chlorination station. Therefore, this pipe must be the active intake to the system.

4.) There are known to be two pipes at the toe of the dam slope - one leading to the system and one to the brook. How the brook pipe is connected to the reservoir or the gatehouse is unknown.

I'd like to discuss these problems and questions and how they might relate to the present dam reconstruction as well as future treatment plant thinking with you soon.

JRM/be
att.

50 Stanford Street Boston Massachusetts 02114
617 523-1900 TWX 710 321 6385 Cable Address METEDD Boston

August 5, 1976

J-4177

Mr. William F. Guillaume
Vice President - Operations
The Connecticut Water Company
93 West Main Street
Clinton, Connecticut 06413

Dear Mr. Guillaume:

Enclosed please find copies of our calculations for a flood-routing through Plymouth Reservoir in Thomaston, Connecticut, as requested in your telephone conversation with Mr. Moody and your letter of July 23, 1976.

The Kennison-Colby Rare Flood method was used to construct the inflow hydrograph for the design storm. The Rare Flood would have a probable frequency of greater than 100 years. The flood routing was done graphically with a two hour interval used for each incremental calculation.

The modified principal spillway and emergency spillway were found to be just capable of passing flood without the dam being overtopped. However, according to our graphical solution, there would be zero freeboard, at the end of the peak two hour interval. An integral solution by computer might result in a small (say 0.1 ft) freeboard during the peak period of the flood. The reservoir was assumed to be at full capacity at the start of the flood. All outflow was assumed to be discharged over the spillways, and none through the 12-inch outlet pipe. Use of the latter would result in some factor of safety.

If you have any questions, please do not hesitate to call.

Very truly yours,

METCALF & EDDY, INC.

Arthur D. Moody
Project Manager

JJP/dc
Encs.

RECEIVED

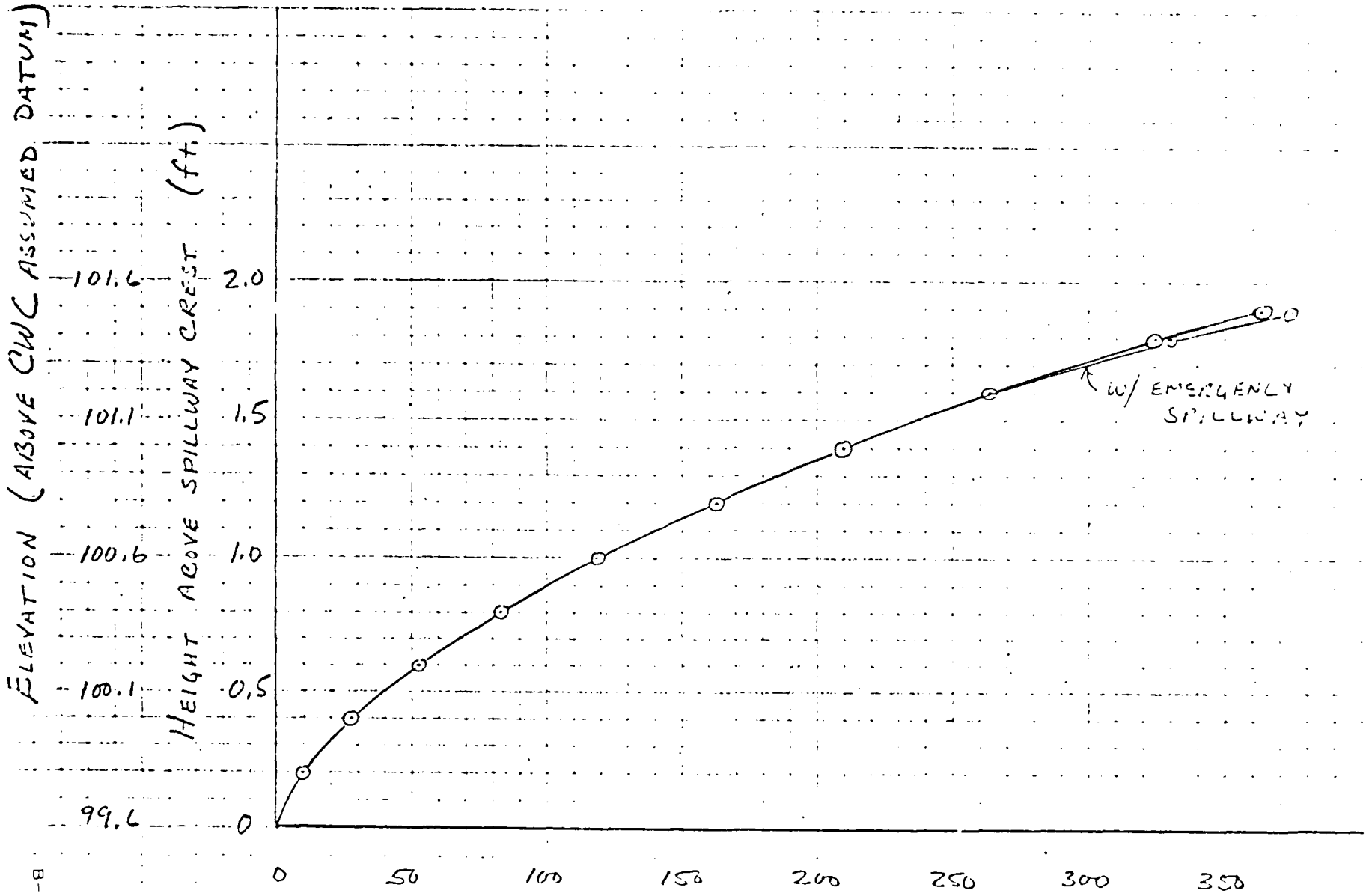
Project CWC Thornton Dam
Subject FLOOD ROUTING Comp'd By J POWERS Date 7-30-76
Detail SPILLWAY CAPACITY Ck'd By Date

ELEV*	H(ft)	$H^{3/2}$	C	L (ft)	Q(cfs)	Q EMERGENCY
99.6	0			40'	0	
99.8	0.2	0.0894	2.71	↓	9.7	
100.0	0.4	0.253	2.77	↓	28.0	
100.2	0.6	0.465	2.80	↓	52.1	
100.4	0.8	0.716	2.88	↓	82.4	
100.6	1.0	1.0	2.98	↓	119.2	
100.8	1.2	1.315	3.08	↓	162.0	
101.0	1.4	1.657	3.17	↓	210.0	0
101.2	1.6	2.024	3.26	↓	263.9	2.5 EST
101.4	1.8	2.415	3.35 EST.	↓	323.6	6 EST
101.5	1.9	6.619	3.40 EST	↓	356.2	8.6

1.5 ft WIDE BROAD CRESTED WEIR
p 5-49 KINGS HANDBOOK

* ASSUMED DATUM FROM CWC SURVEY OF 8/25/75

METCALF & EDDY, ENGINEERS



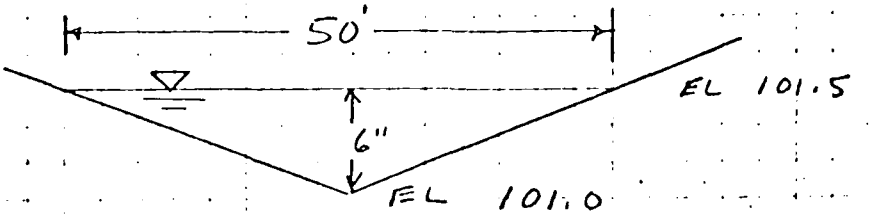
Subject FLOOD PROTECTION Computed By JP Date 7-30-81
Detail SPILLWAY CAPACITY Checked By Date

Project

Subject FLOOD ROUTING Compld By JPowers Date 7-30-76

Detail Ck'd By A Eddy Date 8-9-76

EMERGENCY SPILLWAY CAPACITY



MANNING FORMULA

$$Q = \frac{1.486}{n} \frac{a^{5/6}}{p^{2/3}} S^{1/2}$$

$n = 0.0225$ REF: KING's HANDBOOK p 7-17

a = AREA = $\frac{1}{2}(50)(6/12)$

$= 12.5 \text{ ft}^2$

p = WETTED PERIMETER = 50 ft

S = SLOPE $= \frac{101.0 - 100.0}{56.5 \text{ ft}} = 0.0177$

℄ OF ROAD 56.5 ft AWAY
EL 100.0

$$Q = \frac{1.486}{0.0225} \frac{(12.5)^{5/6}}{(50)^{2/3}} (0.0177)^{1/2}$$

$$= (66.04) \frac{8.21}{13.57} (0.133) = 5.3 \text{ cfs}$$

(CONSERVATIVE)

Subject FLOOD ROUTING Computed By J Powers Date 7-30-76

Detail SPILLWAY CAPACITY Ckd By A. Eddy Date 8-9-76

$$S = \frac{2'}{43'} \quad \frac{101 - 99}{\text{DIST TO HIGHWAY DITCH}}$$

$S^{1/2} = 0.2157$ ✓ $\qquad (0.0177)^{1/2} = 0.133$ ✓

$5.3 \text{ cfs} \left(\frac{0.2157}{0.133}\right) = 8.6 \text{ cfs}$ ✓ (LIBERAL)

NRE JC18 10 x 14.5

METCALF & EDDY, ENGINEERS

Project

Subject FLOOD ROUTING Compld By JPOWERS Date 7-30-76

Detail PLANIMETERED AREAS Ck'd By ALEDDY Date 8-4-76

(FROM U.S.G.S.)

DRAINAGE AREA:

0000 } 4.20
9580 } 4.20 } 4.20 SQ IN ✓ = 385.7AC ✓
0000 } = 0.603 SQ MI ✓

NORMAL WATER SURFACE:
(EL 692)

1932 } 0.38
1970 } 0.39 } 0.385 SQ IN = 35.34 AC ✓
2009 }

AREA WITHIN 700 CONTOUR

4146 } 0.55
4201 } 0.54 } 0.545 SQ IN = 50.03 AC ✓
4255 }

AREA OF SWAMPS

2102 } 0.14
2116 } 0.14 } 0.14 SQ IN = 12.85AC
2130 }

2175 } 0.05
2180 } 0.05 } 0.05 SQ IN = 4.59AC
2185 }

17.44AC

= 4.52 % OF DRAINAGE AREA

Project

Subject FLOOD ROUTING Comp'd By J. PHELPS Date 7-30-76

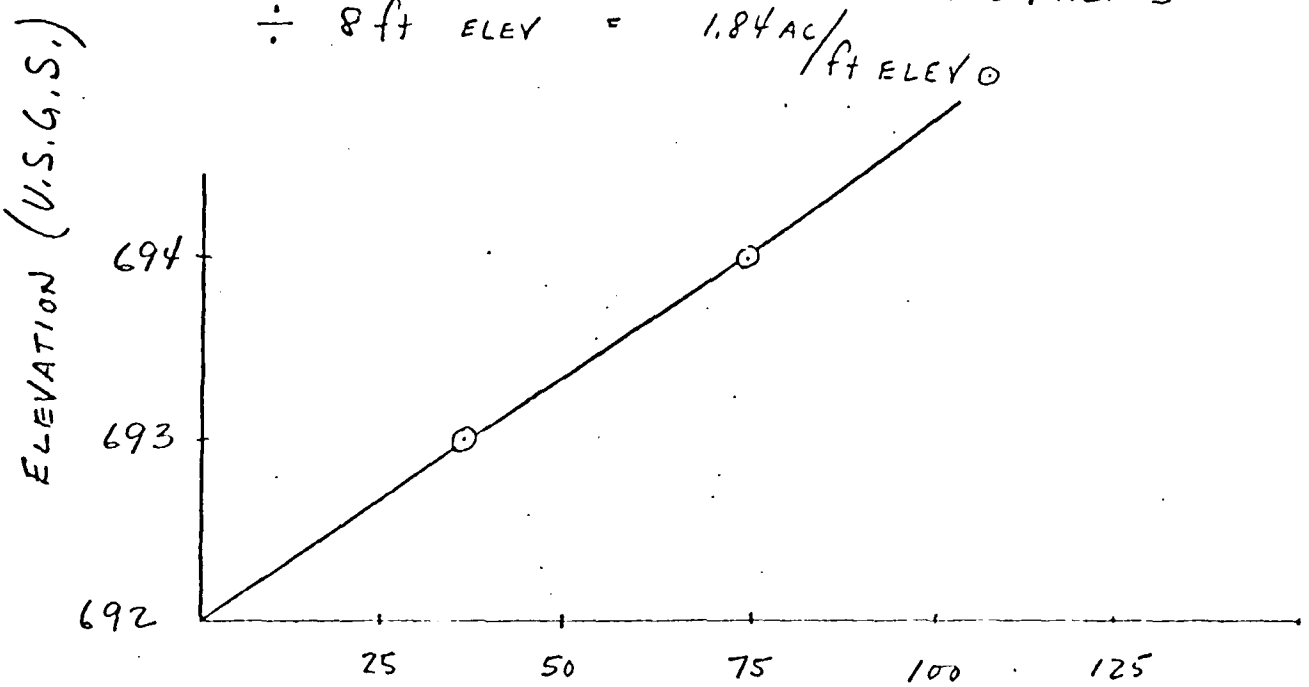
Detail ELEVATION - STORAGE Ck'd By A. WOODY Date 8 4 76

AREA WITHIN 700 CONTOUR 50.03

" " 692 " 35.34

14.69 ACRES ✓

÷ 8 ft ELEV = 1.84 AC/ft ELEV ⊙



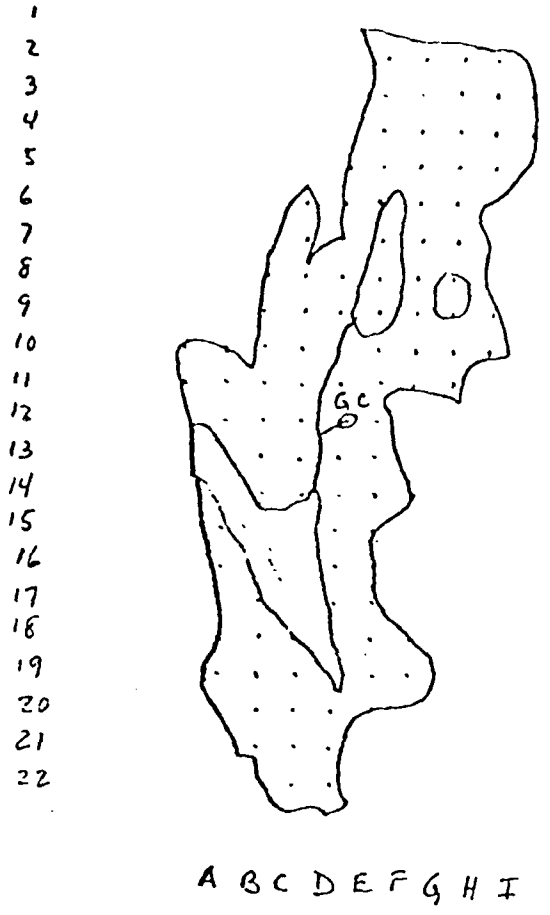
	AREA WITHIN CONTOUR	AVE. AREA (ACRES)	ELEV DIFFER. (FT)	INCREM. STORAGE (ACRE-FT)	CUMULA STORAGE (AC-FT)
EL 692	35.34	36.26	× 1 =	36.26	
EL 693	37.18	38.1	× 1 =	38.1	74.36
EL 694	39.02	39.94	× 1 =	39.94	114.30 ✓
EL 695	40.86				

Subject FLOOD ROUTING Computed By JPowers Date 3-2-76

Detail GEOGRAPHICAL CENTER Ck'd By H.M.Eddy Date 3-4-76

NONREPRODUCIBLE GRID FORM 145

METCALF & EDDY, ENGINEERS



$L = 900$ ft

(DISTANCE FROM CENTER OF GRAVITY TO RES. BY STREAM BED)

AVE ELEV: $\frac{88,550}{112}$

$= 790.62$

DETERMINATION OF GEOGRAPHICAL CENTER OF D.A.

(CENTER OF GRAVITY)

Subject FLOOD ROUTING Computed By JPowers Date 8-2-76

Detail AVE. ELEV. DETERMINATION Checked By [illegible] Date

		A	B	C	D	E	F	G	H	I	
1		—	—	—	—	—	—	—	—	—	1
2		—	—	—	—	880	880	885	890	—	2
3		—	—	—	—	870	860	870	930	930	3
4		—	—	—	—	850	840	845	905	920	4
5		—	—	—	885	830	810	850	890	—	5
6		—	—	870	880	800	810	860	—	—	6
7		—	—	870	900	785	810	870	—	—	7
8		—	830	870	835	780	815	850	—	—	8
9		—	810	845	790	775	815	850	880	—	9
10	750	800	805	800	760	785	820	860	870	—	10
11	720	790	810	810	770	795	810	860	—	—	11
12		730	800	800	750	795	—	—	—	—	12
13		692	735	740	725	785	—	—	—	—	13
14		692	700	700	715	775	780	—	—	—	14
15		700	692	692	720	775	—	—	—	—	15
16		720	692	692	715	800	—	—	—	—	16
17		740	695	692	700	790	—	—	—	—	17
18		755	715	692	692	755	770	—	—	—	18
19		760	740	710	692	745	770	—	—	—	19
20		760	760	730	720	750	—	—	—	—	20
21		—	810	750	760	—	—	—	—	—	21
22		—	—	780	770	—	—	—	—	—	22
		A	B	C	D	E	F	G	H	I	
	1470 (2)	8139 (11)	10,594 (14)	13,043 (17)	13,779 (18)	15,120 (19)	10,590 (12)	8600 (10)	5365 (6)	1850 (2)	

Subject FLOOD ROUTING Compld By J.POWERS Date 8-2-76

Detail AVE ELEV. OF D.A. Ck'd By Date

NONREPRODUCIBLE GRID FORM 143

METCALF & EDDY, ENGINEERS

Project [illegible]
Subject FLOOD ROUTING Computed By J. Powers Date 5-[illegible]
Detail DESIGN FLOOD Chkd By A. Moody Date 5-9-76

KENNISON COLBY FORMULA (RARE FLOOD)

PEAK FLOW $Q = (0.0595\, S^{1.5} + 342) \times \frac{M^{0.95}}{L^{0.7}}$

S = EL 790.62 − 692. = 97.38 ft ✓

$S^{1.5} = 961$ ✓

$M = 0.603$ sq mi, $M^{0.95} = 0.618$.

$L = 900$ ft = 0.17 mi, $L^{0.7} = 0.290$ ✓

$Q = (0.0595 \times 961 + 342) \frac{0.618}{0.290}$

= 850 cfs PEAK FLOW ✓

HYDROGRAPH (RARE FLOOD)

DEPTH OF RUN OFF - INCHES = $D = 8.9 - 0.4q + 0.001E$

q = WATER SURFACE* EXPRESSED AS % OF DRAINAGE AREA

= 4.52 % ✓ * ABOVE RESERVOIR ✓

E = DIFFERENCE BETWEEN AVL. EL. OF D.A AND EL. 800 ft

(EL 792 − 800) − NEGL. DISREGARD ✓

$D = 8.9 - [(0.4)(4.52)] + 0$ = 7.09 INCHES ✓

Subject FLOOD ROUTING — Computed By J.P. [illegible] Date 8-2-71

Detail STEP HYDROGRAPH — Ck'd By A.McCoy Date 8-4-71

INTERVAL HRS	RUN OFF % D	RUN OFF INCHES	RATE OF RUN OFF :	AVE FLOW cfs
0-6	2	0.14	$\times \frac{(5,280)^2}{12} \times \frac{0.603}{60 \times 60 \times 6}$	9
6-12	3	0.21	↓	14
12-18	5	0.35	↓	23
18-24	8	0.57	↓	37
24-30	10	0.71	↓	46
30-36	20	1.42	↓	92
36-42	40	2.84	↓	184
42-48	10	0.71	↓	46
48-54	2	0.14	↓	9
	100	7.09		

Subject FLOOD ROUTING Compld By [illegible] Date [illegible]

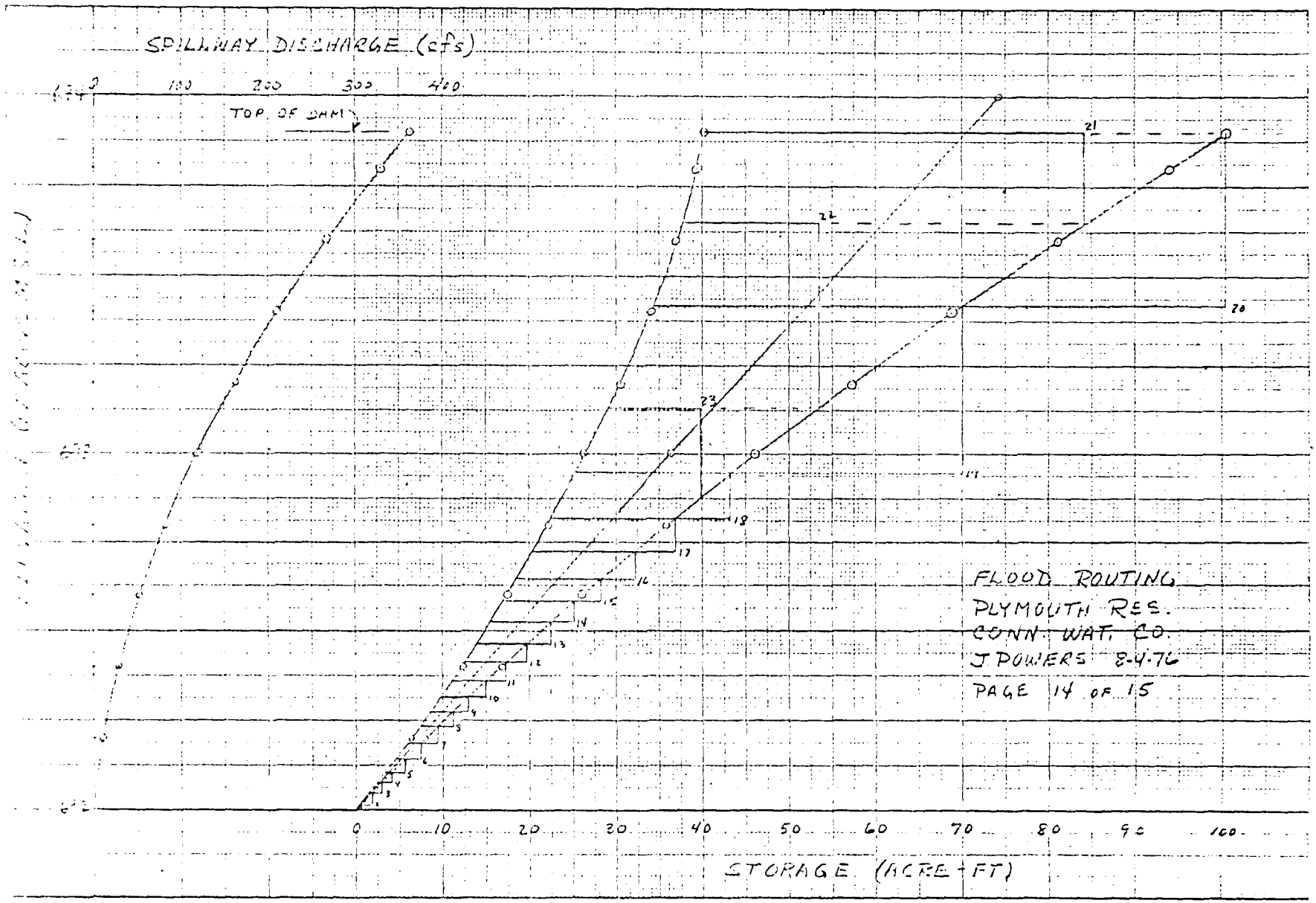
Detail GRAPHICAL SOL-N. Ck'd By A KELLY Date 8-9-76

HEIGHT ABOVE WEIR (ft)	SPILLWAY DISCHARGE (ACRE-FT PER 2HOURS)	1/2 SPILLWAY DISCHARGE (ACRE-FT PER 2HOURS)
0.2	1.6	0.8
0.4	4.63	2.31
0.6	8.61	4.3
0.8	13.61	6.81
1.0	19.69	9.85
1.2	26.76	13.38
1.4	34.68	17.35
1.6	43.85	21.92
1.8	54.45	27.22
1.9	60.27	30.13

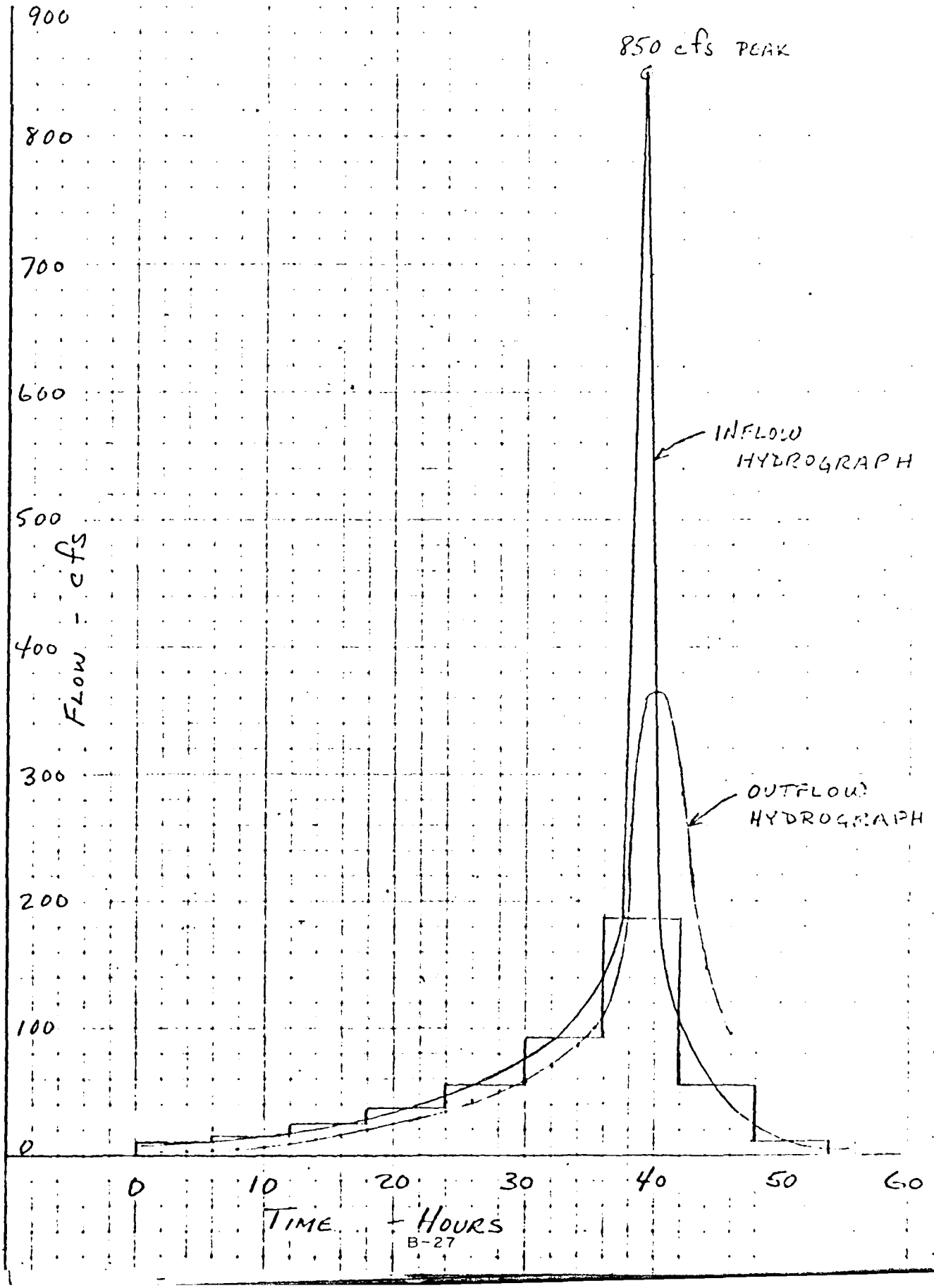
Subject: FLOOD ROUTING   Comp. by: [illegible]   Date: [illegible]
Detail: Ckd by: A. [illegible]   Date: 8-4-[illegible]

STEP	HOURS FROM START OF FLOOD	INSTANTANEOUS RATE OF INFLOW, I (cfs)	SUM OF DISCHARGES START & END $I_1 + I_2$	AVERAGE INFLOW cfs	AVERAGE INFLOW AC-FT	ELEV. AT END OF INTERVAL	DISCHARGE AT END OF INTERVAL cfs
1	2	7	7	3.5	.57	692.01	1
2	4	8	15	7.5	1.24	692.05	2
3	6	10	18	9.0	1.49	692.075	4
4	8	12	22	11.0	1.82	692.1	5
5	10	15	27	13.5	2.23	692.14	6
6	12	18	33	16.5	2.73	692.19	10
7	14	21	39	19.5	3.22	692.24	13
8	16	25	46	23.0	3.8	692.28	16
9	18	29	54	27.0	4.46	692.32	20
10	20	34	63	31.5	5.2	692.36	25
11	22	40	74	37.0	6.11	692.41	30
12	24	46	86	43.0	7.1	692.46	35
13	26	55	101	50.5	8.34	692.525	43
14	28	63	118	59.0	9.74	692.58	50
15	30	75	138	69.0	11.4	692.64	59
16	32	90	165	82.5	13.63	692.725	70
17	34	110	200	100.0	16.52	692.82	86
18	36	140	250	125.0	20.65	692.95	107
19	38	400	540	270	44.6	693.43	216
20	40	400	800	400	66.1	693.9	362
21	42	110	510	265	43.8	693.65	283
22	44	70	190	95	15.7	693.13	146
23	46	40	130	65	10.7	692.875	95

METCALF & EDDY, ENGINEERS


SPILLWAY DISCHARGE (cfs)
0
100
200
300
400
TOP OF DAM
21
22
20
23
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
10
20
30
40
50
60
70
80
90
100
STORAGE (ACRE-FT)
FLOOD ROUTING
PLYMOUTH RES.
CONN. WAT. CO.
J POWERS 8-4-76
PAGE 14 OF 15

Project CWC THOMASTON DAM
Subject FLOOD ROUTING
Detail HYDROGRAPHS



NONREPRODUCIBLE GRID FORM 145

METCALF & EDDY, ENGINEERS

Metcalf & Eddy, Inc. | Engineers & Planners
Statler Building Boston, Massachusetts 02116 (617)423 5600 TWX 710 321-6365 Cable METEDD BOSTON

August 19, 1975

J-4177

Mr. William F. Guillaume
Vice President, Operations
The Thomaston Water Company
General Offices
West Main Street
Clinton, Connecticut 06413

Dear Mr. Guillaume:

An investigation of the seepage and general condition of the Plymouth Reservoir Dam, Plymouth, Connecticut has been completed and our findings and recommendations presented herein. This work was undertaken in accordance with our proposal dated May 15, 1975 and your Purchase Order No. 3722G dated May 20, 1975, in response to the request by the State of Connecticut Department of Environmental Protection dated September 3, 1974.

History

The Thomaston Dam was designed by William B. Rider, hydraulic engineer, in 1880. Review of the appropriate sections of the contract documents provided the following information on the original dam:

1. The embankment was to be 15 feet wide at the top with a slope of two to one on both sides.

2. Through the entire length of the embankment a cemented wall of rubble masonry was to be constructed.

3. The ground surface beneath the wall and the embankment was to be thoroughly cleaned of all muck, porous materials or other deleterious substances. (Note: a later sketch indicated the bottom of the core wall was set 5 feet below grade.)

4. The spillway was to be constructed of shingled masonry laid up dry in the form of steps, with each layer of stone covered at least three-fourths of its length by the layer above.

5. The spillway wing walls were to be 5-foot thick bonded masonry extending across the entire dam section.

6. The embankment was to be constructed by placing puddle (soil wet of optimum moisture content) of selected gravel (maximum size 2 inches) and clay in horizontal layers not exceeding 6 inches in thickness. Each layer was to set until firm and stiff before being harrowed and watered prior to the application of the next layer.

7. The entire surface of the embankment of the upstream slope was to be paved with rip-rap of at least 12 inches in thickness.

The dam was apparently constructed during 1880 and 1881. A check of the final quantities against the design configuration was made and indicates close agreement.

In 1910 the dam was raised 16 inches and the embankment strengthened. In 1921 additional work involving rip-rap on the dam was performed. It is not known what work was actually performed on the dam under these two contracts.

Investigation

To investigate the condition within the present structure, a program of soil sampling and installation of piezometers was undertaken. The field work was performed by Associated Boring Company, Inc. of Naugatuck, Connecticut under contract to the Thomaston Water Company and inspected by geologist A. Scott Nagle of Metcalf & Eddy.

The subsurface investigation included 10 borings across the dam cross-section approximately 50 feet south of the spillway, and one boring 20 feet north of the spillway just downstream of the axis of the dam. Each boring was sampled at the ground surface and at 5 foot intervals. At a predetermined depth, the hole was terminated and a piezometer installed to establish the piezometric heads at specific locations within the dam. After evaluation of the soil boring results and piezometer data, six additional shallow piezometers were installed in hand auger holes to determine the phreatic surface beneath the surface of the downstream slope of the embankment.

Figure 1 shows a plan of the dam and the location of the various borings. The boring logs prepared by Associated Boring Company are attached at the end of this letter and give the drillers' description of the soil encountered.

Laboratory tests were run on several samples. The results are presented in the following table:

Sample			Atterberg limits		Natural water content	Unified soil classification group symbol
Boring	Sample	Depth	Liquid limit	Plastic index		
W-4	3	10-11 1/2	43.7	7.4	37	ML
W-4	5	20-21 1/2	28.5	2.6	22.3	ML
W-5	4	15-16 1/2	nonplastic		-	ML
W-7	2	5-6 1/2	39	9.4	-	ML

In general, the embankment material is classified as brown to dark brown inorganic silt and very fine sands with slight plasticity and traces of medium to coarse sand and fine gravel. The underlying material is a residual soil, or rock decomposing in place which becomes more rock-like in structure and strength with increasing depth.

The blow counts within the embankment are very low, at about two blows per foot but range down to one blow per foot indicating the material to be very loose or very soft. A slightly plastic silt of this type would normally be expected to have a drained angle of internal friction of about 26 degrees plus a cohesive strength of several hundred pounds per square foot. In an undrained condition, the angle of internal friction would be decreased, possibly to the order of 5 to 10 degrees with the cohesion remaining unchanged. The dry unit weight should be about 80 pounds per cubic foot and the saturated unit weight about 112 pounds per cubic foot.

Figure 2 is a section through the dam showing the soil condition and blow counts encountered. The configuration of the dam slopes was determined by actual measurements extending about 85 feet on either side of the dam center line. Note that the downstream slope plots about 2-1/4 to 1 while the upstream slope plots about 3 to 1. It is suspected that during either the 1910 or 1921 work on the dam the upstream face was flattened to its present slope.

Flow Analysis

The piezometers were read after completion and at periodic intervals thereafter to assure that an equilibrium condition had been reached. Using data taken July 1, 1975, equipotential lines have been superimposed on the dam section and are presented in Figure 3.

Readings indicate only a 2.7 foot drop in head between piezometer W-1 and W-3 indicating a virtually unimpeded flow through the core wall. The spacing of the equipotential lines indicates some variability of the embankment permeability -- being least permeable in the embankment half just downstream of the core wall, and becoming more permeable in the embankment half near the toe.

Based on the head differential of about 2 feet between the piezometers at mid slope and the toe, a distance of about 16 feet, an exit gradient of 0.13 is calculated. For a silty soil flow out through the embankment slope could be sufficient to dislodge soil particles and permit deterioration of the dam.

Summarizing, the core wall is leaking and permitting seepage to exit on the downstream slope of the dam, a condition that can cause erosion of the embankment.

Stability Analysis

An analysis was performed to determine the stability of the embankment against rotational shear failure. It was concluded that any attempt to obtain undisturbed soil samples for triaxial shear testing in the laboratory to determine soil strengths would be prohibitively expensive, if indeed possible. Loose fine soils and silts are very difficult to sample, transport and test without causing some disturbance to the soil structure, thus destroying the properties to be tested.

Therefore, analyses were run to determine the factor of safety using several assumed soil properties and the result compared with the probable soil strengths.

Initially the stability was investigated by varying the angle of internal friction and then by adding cohesion. Based on these analyses, it is felt that the dam with a full reservoir has a safety factor of about 1.4 against a deep rotational failure of the downstream slope using an angle of interval friction of 26 degrees and a cohesion of 100 pounds per square foot. Lowering the reservoirs appears to improve the safety factor by 0.1 for each 2 feet of drawdown.

Because of the very loose condition of the embankment soil, there is a concern of what would happen should any vibration, such as resulting from an earthquake, local blasting or similar event, occur. Typically, a loose soil will tend to densify when vibration occurs thus causing liquifaction, a temporary loss of intergranular friction and corresponding increase in pore water pressure. In an undrained condition using an angle of internal friction of 10 degrees and a cohesion of 100 pounds per square foot, the downstream embankment of the dam has a safety factor of less than 1.

Summarizing, the condition of the dam embankment under static conditions using assumed soil values is satisfactory. However, vibratory disturbance could result in failure of the downstream embankment.

Recommendations

It is necessary to intercept and eliminate seepage from the downstream toe of the dam and to improve the strength of the downstream slope to reduce the possibility of failure from dynamic forces.

To accomplish both goals it is recommended that a new toe drain be installed; the outer 3 feet of the existing embankment be removed; the top downstream of the core wall be excavated to elevation 94, and that the removed material be replaced with compacted granular material and a new slope of 3 horizontal to 1 vertical be constructed. To permit the slope flattening, gabions should be placed parallel to the road where the new slope will extend beyond the property line.

The toe drain should consist of a 6-inch diameter perforate pipe with filter envelopes of 3/4-inch course aggregate and concrete sand to prevent any migration of the protected soil. The invert of the toe drain should extend about 1 foot below the overburden soil into the denser decomposed rock or residual soil. The gabions should be founded directly on the decomposed rock and have a backward rake of 1 horizontal to 6 vertical. Figure 4 shows a typical section for the slope with the gabions and without.

By installing the underdrain and gabion, starting at the spillway, in short sections and completing back to original grade prior to any slope excavation, it is our opinion that the work can be performed with the reservoir lowered about 8 inches by removing the concrete cap along the spillway crest. Prior to excavating embankment material, a period of time - say several weeks - should be allowed to permit drainage and lowering of the phreatic surface. This can be field checked with well points pushed into the embankment.

All work performed on the dam should be performed under the immediate close supervision of a qualified engineer. It is necessary that the work be watched closely for evidence of excessive leakage, piping, slumping, sliding, etc., and that prom action be taken to stop the condition should it develop. It is recommended that several loads of pervious material be stockpiled adjacent to the work area at all times to cover or push over a questionable condition should it occur.

The new filters and underdrains will effectively lower the phreatic surface and lesson the chance for liquification to occur under vibration loadings. In addition, the new granular fill will increase the effective stress between soil particles thus providing greater strength, and at the same time, because of the flatter slope, reduce the shearing stresses.

Should you have questions concerning our findings or recommendations, or if you wish to discuss any aspect further, please do not hesitate to call.

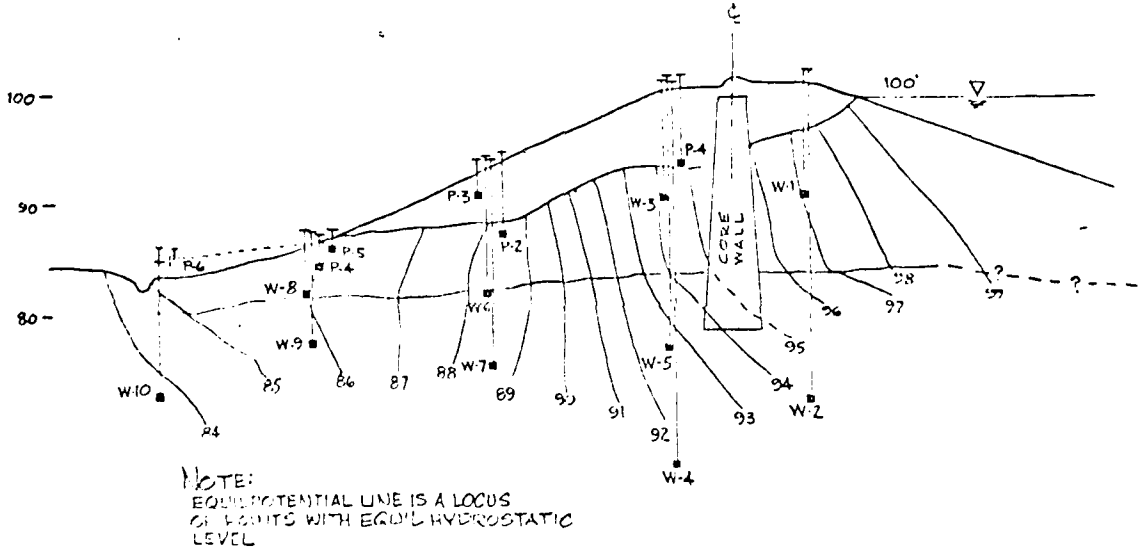
Very truly yours,

METCALF & EDDY, INC.

George K. Tozer
Vice President

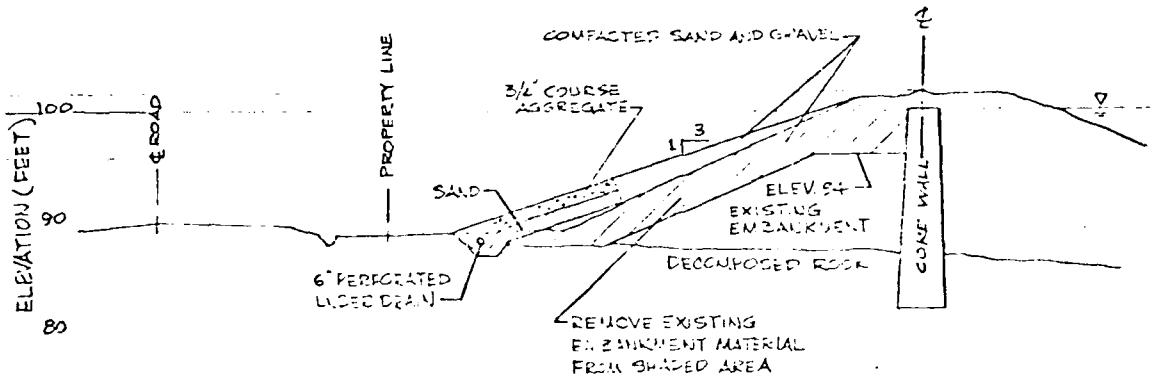
EBM:jfg

Att.



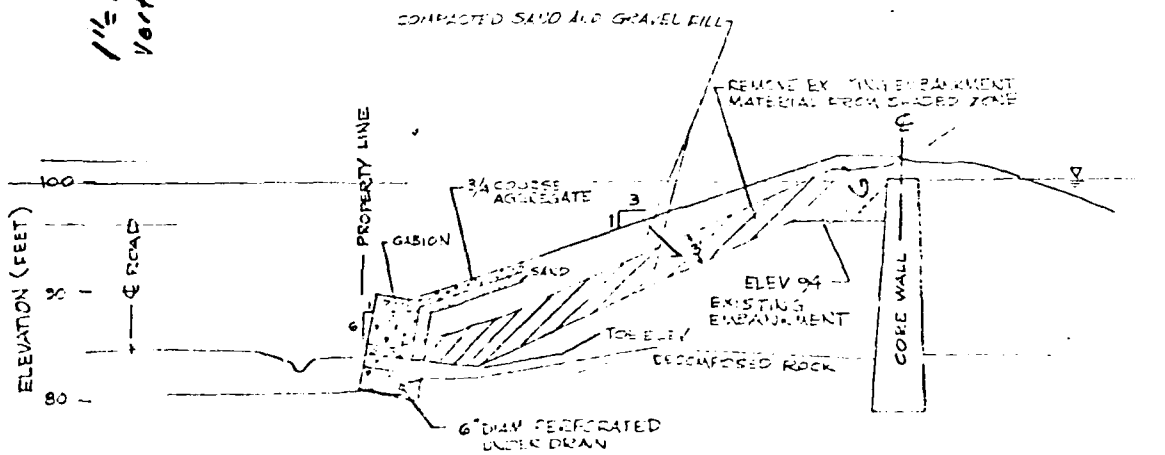
NOTE:
EQUIPOTENTIAL LINE IS A LOCUS OF POINTS WITH EQUAL HYDROSTATIC LEVEL

FIG. 3 DAM SECTION WITH EQUIPOTENTIAL LINES



SECTION WITHOUT GABION
SCALE 1" = 10'

1" = 16'
Vert.



SECTION WITH GABION
SCALE 1" = 10'

USE GABION WHERE 3:1 SLOPE EXTENDS BEYOND PROPERTY LINE.

3/5 × 16 = 6'

FIG 4 RECOMMENDED REHABILITATION

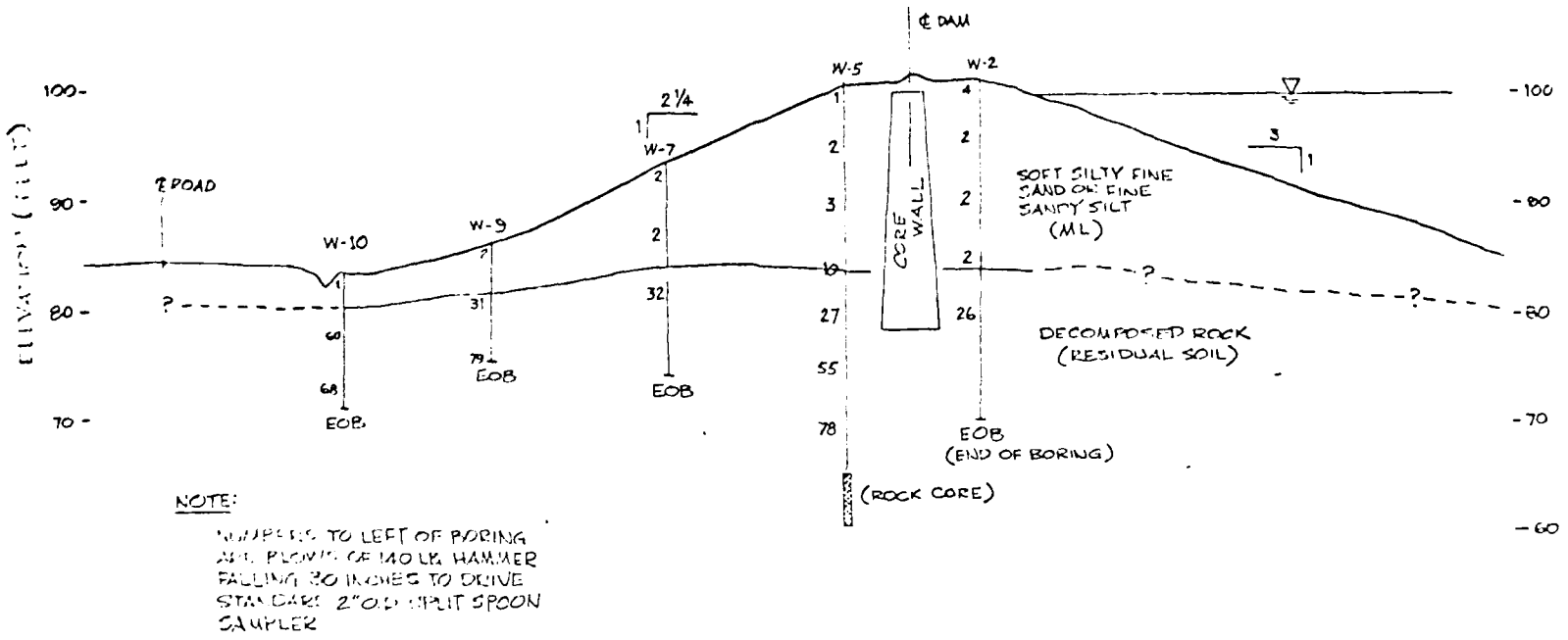


FIG. 2 DAM SECTION 50 FT. SOUTH OF SPILLWAY

Associated Borings Company, Inc.

119 MARGARET CIRCLE, NAUGATUCK, CONN. 06770
AREA CODE (203) 729-5435

P L Y M O U T H R E S E R V O I R

P L Y M O U T H, C O N N E C T I C U T.

NAUGATUCK, CONN. 06770
PHONE 729-5435

TEST BORING REPORT

CLIENT Metcalf & Eddy, Engineers

BORING NO. 1
LINE & STA.
OFFSET
GR. ELEV.
DATE 6-16-75
M. Lloret
A. Daddona

	A STRATUM DESCRIPTION	DENSITY OR CONSIST.	BLOWS PER 6" B
0'1	Topsoil	Loose	1-1
	Br. M-F Silty Sand, Some F. Grav., Root Fibres.	Moist Rec:6"	2
	"	Loose Wet Rec:0"	1-1 1
3'0	Br. M-F Silty Sand, Tr.* F. Grev., Tr. Decomp. Rock, Root Fibres.	*Rec:11"	Push
		Loose Wet Rec:6"	1-1 1
11'5	End of Boring at 11'5		
	GWO -4'0 at "0" Hrs.		
	**Installed OW at 10'8		
	Remarks:		
	*Pushed from 6'5 to 8'0		
	**OW- Observation Well		

BORING NO. 2
LINE & STA.
OFFSET
GR. ELEV.
DATE 6-17-75

	A STRATUM DESCRIPTION	DENSITY OR CONSIST.	BLOWS PER 6" B
0'2	Topsoil	Loose	2-2
	Br. Silt, Tr.F.Sand, Tr.F.Grav., Tr. Decomp. Rock, Root Fibres.	Moist Rec:6"	2
	"	Loose Wet Rec:0"	1-1 1
		*Rec:16"	Push
16'0	"	Loose Wet	1-1 1
16'5	Gray Silt, Some F. Grav., Tr. Decomp. Rock	Rec:18"	
17'0	Dark Br. Silt Decomp. Rock		
	"	Loose Wet Rec:7"	1-1 1
	"	M. Comp. Wet Rec:13"	9-11 15
	"	Dense Moist Rec:6"	85-50/1"
31'0			
	End of Boring at 31'0		
	GWO -4'0 at "0" Hrs.		
	**Installed OW at 29'0		
	Remarks:		
	* Pushed from 6'5 to 8'0		
	** OW- Observation Well		
	Augered to 31'0		

1 COL. A Blows on Casing
2 COL. B Blows on 1⅜" Sampler (I.D.)
3 HAMMER = 140#; FALL 30"
4 SAMPLER = O. D. SPLIT SPOON
5 GWO = GROUND WATER OBSERVATIONS

FIELD — % CONTENT
AND — 40 to 50%
SOME — 10 to 40%
TRACE — 0 to 10%

119 MARGARET CIRCLE
NEW CANAAN, CONN. 06770
PHONE 729-5435

TEST BORING REPORT

PROJ. Plymouth Reservoir, Plymouth, Mass.
CLIENT Metcalf & Eddy, Engineers

BORING NO. 3
LINE & STA.
OFFSET
GR. ELEV.
DATE 6-11-75
M. Lloret
A. Daddona

	A STRATUM DESCRIPTION	DENSITY OR CONSIST.	BLOWS PER 6" B
0'2	Topsoil	Loose	2-2
	Br. M-F Sand, Some F. Grav., Tr. Decomp. Rock, Root Fibres.	Moist Rec:8"	2
1'5	Dark Gray Clayey Silt, Tr. F. Sand, Tr. Cobble, Tr. Rock Frags, Tr. Root Fibres, Slightly Org.	Loose Wet Rec:18"	1-1/12"
		Loose Moist Rec:5"	17-3 5
11'5	End of Boring at 11'5		
	G/O -5'5 at "0" Hrs		
	Installed OW at -10'0		

BORING NO. 4
LINE & STA.
OFFSET
GR. ELEV.
DATE 6-12-75

	A STRATUM DESCRIPTION	DENSITY OR CONSIST.	BLOWS PER 6" B
0'2	Topsoil	Loose	1-2
	Br. M-F Sand, Tr. F. Grav., Tr. Mica, Rock Frags.	Moist Rec:8"	1-1
4'0	Dark Gray Clayey Silt, Tr. F. Sand, Tr. Decomp. Rock, Tr. Root Fibres, Micacious.	Loose Wet Rec:14"	1-1 1
	"	Loose Wet Rec:13"	1-1 1
18'0	" (Some Decomp. Rock)	M. Comp. Wet Rec:9"	8-9 3
21'0	Gray F. Silty Sand, Some F. Grav., Micacious.	M. Comp. Moist Rec:8"	10-9 12
	Gray F. Silty Sand, Some F. Grav. & Decomp. Rock, Rock Frags.	M. Comp. Moist Rec:11"	30-32 36
	"	Dense Moist Rec:10"	20-32 70
35'5	Refusal at 35'5	Dense Moist Rec:6"	90/6"
	End of Boring at 35'5		
	G/O -5'5 at "0" Hrs.		
	Installed OW at 21'0		

1 COL. A Blows on Casing
2 COL. B Blows on 1⅜" Sampler (I.D.)
3 HAMMER = 140#; FALL 30"
4 SAMPLER = O. D. SPLIT SPOON

FIELD — % CONTENT
AND — 40 to 50%
SOME — 10 to 40%

SSOCIATED BORINGS CO., INC.
9 MARGARET CIRCLE
AI TATUCK, CONN. 06770
HONE 729-5435

TEST BORING REPORT

PROJ. Plymouth Reservoir, Plymouth, [illegible]

CLIENT [illegible]

BORING NO. 5
LINE & STA.
OFFSET
GR. ELEV.
DATE 6-09-75

A STRATUM DESCRIPTION	DENSITY OR CONSIST.	BLOWS PER 6" B
Topsoil	Loose	1-1
Br. M-F Silty Sand, Some Dark Br. Silt, Tr. F. Grav, Tr. Cobbles, Tr. Root Fibres.	Moist Rec:6"	1
	Loose Wet Rec:4"	2-1 1
Dark Br. F. Sand, Some Silt, Some Decomp. Rock, Tr. F. Grav., Root Fibres	Loose Moist Rec:14"	1-1 2
Dark Br. F. Sand, Some Silt, Tr. F. Grav., Tr. Decomp. Rock, Rock Frags	Loose Wet Rec:9"	1-2 8
Gray M-F Sand, Some Silt, Some Decomp. Rock, Tr. F. Grav.	M. Comp. Wet Rec:7"	10-13 14
Gray Br. M-F Sand, Tr. Silt, Tr. F Grav., Tr. Decomp. Rock, Cobbles, Cemented	V. Comp. Moist Rec:11"	15-25 30
(Some Decomposed Rock)		
Decomposed Rock	Dense Moist Rec:12"	23-33 45
3 Decomposed Mica Schist 2 w/quartzite 3 Run #1: from 35'0 to 40'0 4 Recovery: 4"	Dense Rec:0"	50/0"
End of Boring at 40'0		
GWO -8'0 at "0" Hrs. -7'0 at 24 Hrs.		

BORING NO.
LINE & STA.
OFFSET
GR. ELEV.
DATE

A STRATUM DESCRIPTION	DENSITY OR CONSIST.	BLOWS PER 6" B
Installed CI at 2315		
Remarks: Drill Time Per Ft. is shown in Column A		

1 COL. A Blows on Casing
2 COL. B Blows on 1 3/8" Sampler (I.D.)
3 HAMMER = 140 #, FALL 30"
4 SAMPLER O.D. SPLIT SPOON

FIELD -- % CONTENT
AND — 40 to 50%
SOILS — 10 to 40%

[illegible]
119 MARGARET CIRCLE
NEW HAVEN, CONN. 06770
PHONE 389-9433

TEST BORING REPORT

PROJ. Plymouth Reservoir, Plymouth, Conn.
CLIENT Metcalf & Eddy, Boston, Mass.

BORING NO. 5
LINE & STA.
OFFSET
GR. ELEV.
DATE 6-09-75

BORING NO.
LINE & STA.
OFFSET
GR. ELEV.
DATE

	A	STRATUM DESCRIPTION	DENSITY OR CONSIST.	BLOWS PER 6" B
2'0		Topsoil	Loose Moist Rec:6"	1-1 1
		Br. M-F Silty Sand, Some Dark Br. Silt, Tr. F. Grav, Tr. Cobbles, Tr. Root Fibres.		
7'0		Dark Br. F. Sand, Some Silt, Some Decomp. Rock, Tr. F. Grav., Root Fibres	Loose Wet Rec:4"	2-1 1
12'0		Dark Br. F. Sand, Some Silt, Tr. F. Grav., Tr. Decomp. Rock, Rock Frags	Loose Moist Rec:14"	1-1 2
17'		Gray M-F Sand, Some Silt, Some Decomp. Rock, Tr. F. Grav.	Loose Wet Rec:9"	1-2 8
23'0		Gray Br. M-F Sand, Tr. Silt, Tr. F Grav., Tr. Decomp. Rock, Cobbles, Cemented	M. Comp. Wet Rec:7"	10-13 14
29'0		(Some Decomposed rock)	V. Comp. Moist Rec:11"	15-25 30
30'		Decomposed Rock	Dense Moist Rec:12"	23-33 45
35'0	3 2 3 4	Decomposed Mica Schist w/quartzite Run #1: from 35'0 to 40'0 Recovery: 4"	Dense Rec:0"	50/0"
40'	4			
		End of Boring at 40'0		
		GWO -8'0 at "0" Hrs. -7'0 at 24 Hrs.		

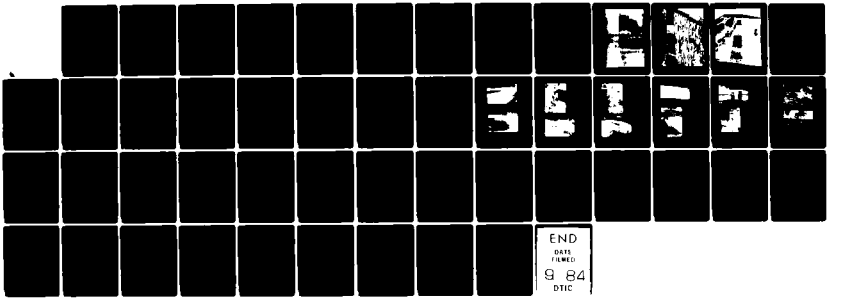
A	STRATUM DESCRIPTION	DENSITY OR CONSIST.	BLOWS PER 6" B
	Installed CI at 23'5		
	Remarks: Drill Time Per Ft. is shown in Column A		

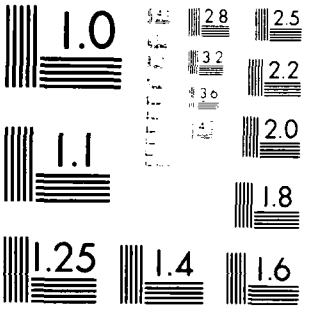
1 COL. A Blows on Casing
2 COL. B Blows on 1⅜" Sampler (I.D.)
3 HAMMER = 140 #, FALL 30"

FIELD — % CONTENT
AND — 40 to 50%

AD-A144 072 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS PLYMOUTH RESERVOIR DA..(U) CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV MAY 81 2/2

UNCLASSIFIED F/G 13/13 NL





SSOCIATED ENGINEERING CO., INC.
39 SARGENT CIRCLE
NEW BRITAIN, CONN. 06050
PHONE 229-5433

TEST BORING REPORT

PROJ. [illegible]

CLIENT [illegible]

BORING NO. 5
LINE & STA.
OFFSET
GR. ELEV.
DATE 6-03-75

BORING NO.
LINE & STA.
OFFSET
GR. ELEV.
DATE

	A STRATUM DESCRIPTION	DENSITY OR CONSIST.	BLOWS PER 6" B
2'0	Topsoil	Loose	1-1
	Br. M-F Silty Sand, Some Dark Br. Silt, Tr. F. Grav, Tr. Cobbles, Tr. Root Fibres.	Moist Rec:6"	1
2'		Loose Wet	2-1
	Dark Br. F. Sand, Some Silt, Some Decomp. Rock, Tr. F. Grav., Root Fibres	Rec:4"	1
13'0		Loose Moist Rec:14"	1-1 2
	Dark Br. F. Sand, Some Silt, Tr. F. Grav., Tr. Decomp. Rock, Rock Frags	Loose Wet	1-2 8
17'0	Gray M-F Sand, Some Silt, Some Decomp. Rock, Tr. F. Grav.	Rec:9"	
23'0		M. Comp. Wet Rec:7"	10-13 14
	Gray Br. M-F Sand, Tr. Silt, Tr. F Grav., Tr. Decomp. Rock, Cobbles, Cemented	V. Comp. Moist Rec:11"	15-25 30
29'0			
30'0	(Some Decomposed rock)		
	Decomposed Rock	Dense Moist Rec:12"	23-33 45
35'0			
	3 Decomposed Mica Schist 2 w/quartzite 3 Run #1: from 35'0 to 40'0 4 Recovery: 4"	Dense Rec:0"	50/0"
40'0	4		
	End of Boring at 40'0		
	GWO -8'0 at "0" Hrs. -7'0 at 24 Hrs.		

	A STRATUM DESCRIPTION	DENSITY OR CONSIST.	BLOWS PER 6" B
	Installed Cl at 2315		
	Remarks: Drill Tire Per Ft. is shown in Column A		

1 COL. A Blows on Casing
2 COL. B Blows on 1 3/8" Sampler (I.D.)
3 HAMMER = 140 #; FALL 30"

FIELD -- % CONTENT
AND -- 40 to 50%

19 MARGARET CIRCLE
NEW STOCK, CONN. 06770
(203) 729-5435

TEST BORING REPORT

PROJ. Plymouth Reservoir, Plymouth, Conn.
Metcalf & Eddy, Engineers.
CLIENT

BORING NO. 6	BORING NO 7
LINE & STA.	LINE & STA.
OFFSET	OFFSET
GR. ELEV.	GR. ELEV.
DATE 6-20-75	DATE 6-19-75
T.Lloret J.Cody	

	A STRATUM DESCRIPTION	DENSITY OR CONSIST.	BLOWS PER 6" B
10	2 Topsoil	Loose	1-1
	11 Br. M-F Clayey Silty	Moist	1-3
	24 Sand, Some M-F Grav.	Rec:0"	
	21	*Rec:10"	
10	22		
	7 Gray M-F Clayey Silty	Loose	1-1
10	6 Sand, Some M-F Grav.	Wet	1
	12 Gray M-F Sand & Grav.	Rec:12"	
	16 Some Silt, Tr.Clay.		
	18		
	"	Comp.	19-19
21		Wet	16
		Rec:15"	
	End of Boring at 12'5		
	GWO -6'0 at "0" Hrs.		
	*Installed OW at 12'0		
	Remarks:		
	Last sample ended at 11'5 but washed to 12'5 for OW installation.		

	A STRATUM DESCRIPTION	DENSITY OR CONSIST.	BLOWS PER 6" B
1'0	3 Topsoil	Loose	1-1
	6 Br. M-F Clayey Silty	Moist	1-4
	10 Sand, Tr. M-F Grav.	Rec:8"	
	11		
5'5	9		
	5 Gray M-F Sandy Silt,	Loose	3-1
	7 Tr.F. Grav, Rock Frags	Wet	1
	12	Rec:13"	
	12		
	8		
11'0	77 "	Comp.	22-17
	75 Decomposed Rock	Moist	15
	133	Rec:12"	
	170		
19'2			
	End of Boring at 19'2		
	GWO -6'0 at "0" Hrs.		
	**Installed OW at 18'7		
	Remarks:		
	Drove casing to 14'0 then washed and drove with chopping bit to 19'2 where refusal was encountered.		
	** Observation Well		

1 COL. A Blows on Casing
2 COL. B Blows on 1⅜" Sampler (I.D.)
3 HAMMER = 140 #; FALL 30"
4 SAMPLER = O. D. SPLIT SPOON

FIELD — % CONTENT
AND — 40 to 50%
SOME — 10 to 40%

119 MARGARET CIRCLE [illegible] GUATUCK, CONN. 06779 PHONE 729-5435	TEST BORING REPORT	PROJ. [illegible] CLIENT [illegible]

BORING NO. 3
LINE & STA. _____
OFFSET _____
GR. ELEV. _____
DATE 6-19-75
M. Lloret
A. Daddona

	A STRATUM DESCRIPTION	DENSITY OR CONSIST.	BLOWS PER 6" B
0'2	Topsoil	Loose	1-1
	Br. Silty Sand, Tr. F. Grav., Root Fibres	Wet Rec:6"	1
1'2	Gray Silty F. Sand, Tr. F. Grav., Tr. Decomp. Rock.	M. Comp. Wet Rec:12"	10-13 13
6'5	End of Boring at 6'5		
	GWO -1'0 at "0" Hrs.		
	**Installed OW at 6'0		
	Remarks: ** Observation Well		

BORING NO. 9
LINE & STA. _____
OFFSET _____
GR. ELEV. _____
DATE 6-19-75

	A STRATUM DESCRIPTION	DENSITY OR CONSIST.	BLOWS PER 6" B
0'2	Topsoil	Loose	1-1
	Br. Silty Sand, Tr. F. Grav., Root Fibres.	Wet Rec:6"	1
4'5	Decomp. Rock		
	"	Comp. Moist Rec:18"	7-13 18
11'5	"	Dense Moist Rec:14"	29-37 42
	End of Boring at 11'5		
	GWO -1'0 at "0" Hrs.		
	**Installed OW at 10'0		
	Remarks: ** Observation Well		

1 COL. A Blows on Casing
2 COL. B Blows on 1⅜" Sampler (I.D.)
3 HAMMER = 140 #; FALL 30"
4 SAMPLER = O. D. SPLIT SPOON
5 GWO = GROUND WATER OBSERVATIONS

FIELD — % CONTENT
AND — 40 to 50%
SOME — 10 to 40%
TRACE — 0 to 10%

AS ...
11 MARGARET CIRCLE
NA DATUCK, CONN. 06770
PH NE 7?? 5435

TEST BORING REPORT

PROJ ...
CLIENT ...

BORING NO. 10
LINE & STA. ____
OFFSET ____
GR. ELEV. ____
DATE 6-19-75

M.Iloret
A.Daddona

	A STRATUM DESCRIPTION	DENSITY OR CONSIST.	BLOWS PER 6" B
0'0"	Topsoil	Loose Wet Rec:9"	1-1/12"
3'0	Gray Silty Sand		
	Gray M-F Silty Sand, Tr.F. Grav.,Tr.Mica.	V.Comp. Wet Rec:14"	29-35 25
6'0	Decomposed Rock		
12'5		V.Comp. Moist	23-31 37
	End of Boring at 12'5		
	GWO -1'0 at "C" Hrs.		
	**Installed GW at 12'0		
	Remarks: **Observation Well Augered to 12'5 to install well at 12'0		

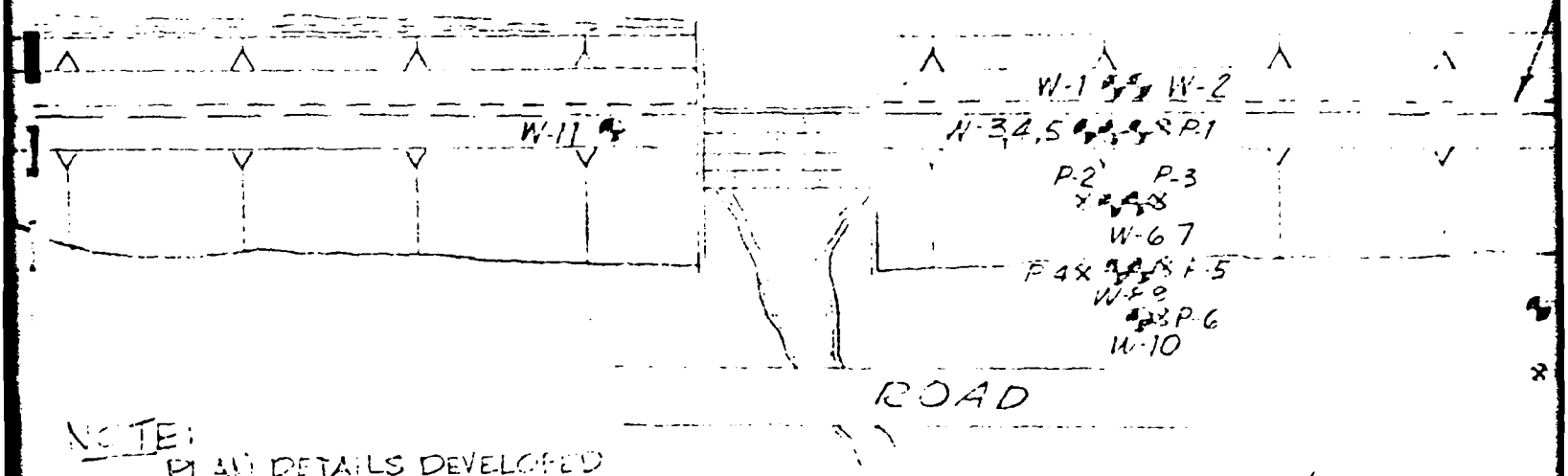
BORING NO. 11
LINE & STA. ____
OFFSET ____
GR. ELEV. ____
DATE 6-20-75

	A STRATUM DESCRIPTION	DENSITY OR CONSIST.	BLOWS PER 6" B
0'2"	Topsoil	Loose Moist Rec:6"	2-2 3
2'5	Br. M-F Silty Sand,Tr F.Grav.,Tr. Decomp. Rock,Root Fibers,Tr. Mica.		
	Dark Br. F. Silty Sand,Tr. F. Grav., Tr.Decomp.Rock,Root Fibers,Slightly Org. Micaceous.	Loose Wet Rec:0" Loose Wet Rec:15"	1-1 1-1 1-1-1
10'0	(Rock Frags,Some Decomp. Rock.)	M.Comp. Wet Rec:9"	7-10 14
		Loose Wet	2-2 3
19'8		Dense Wet	120/3"
	Refusal at 19'8	Rec:0"	
	End of Boring at 19'8		
	GWO -6'0 at "0" Hrs.		
	**Installed GW at 19'5		
	Remarks: ** Observation Well		

1 COL. A Blows on Casing
2 COL. B Blows on 1⅜" Sampler (I.D.)
3 HAMMER = 140#, FALL 30"
4 SAMPLER = O. D. SPLIT SPOON

FIELD — % CONTENT
AND — 40 to 50%
SOME — 10 to 40%

THOMASTON

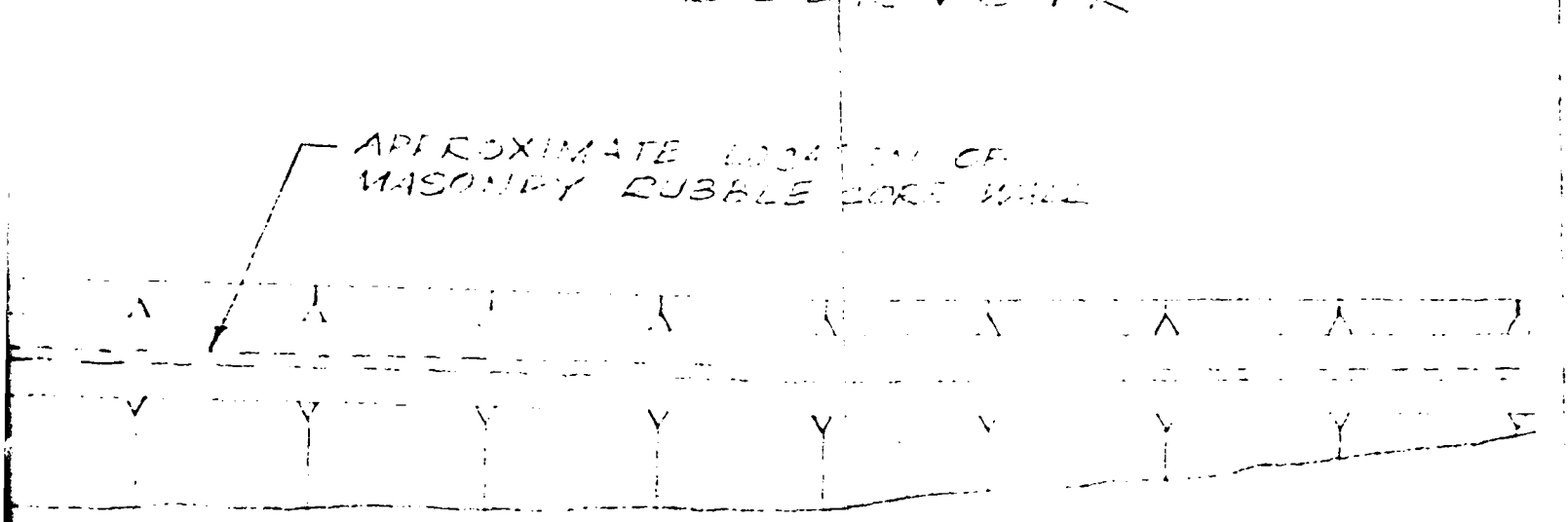


NOTE:
PLAN DETAILS DEVELOPED FROM OLD MAPS AND MAY DEVIATE FROM ACTUAL FIELD CONDITIONS EXISTING NOW.

PLAN

0 40 80 120

SCALE IN FEET



PIEZOMETER IN BORING

PIEZOMETER IN HAND AUGER HOLE

120

FIG 1 SITE PLAN
BORING LOCATIONS

S. E. MINOR & CO., INC.
CIVIL ENGINEERS
161 MASON STREET
GREENWICH, CONNECTICUT 06830

July 15, 1974

State of Connecticut
Department of Environmental Protection
State Office Building
Hartford, Connecticut 06115

Attention: Mr. Victor F. Galgowski
Superintendent of Dam Maintenance
Water and Related Resources

Re: Plymouth Reservoir
Plymouth, Connecticut

Dear Mr. Galgowski:

In accordance with your request, we have examined the subject dam in order to ascertain its structural soundness and stability. Prior to our visit to the site, we went to the Town Hall offices and attempted to obtain any structural drawings of the subject installation. We were advised that no plans were on file and that the Town Officials had no knowledge whatsoever of the construction of the dam.

Upon our visit to the site, we found the Plymouth Reservoir dam to be an earth dam with a total length of approximately 700 feet. There is a concrete spillway with concrete cheek walls and stone steps, which have a total drop of approximately 25 feet. The earth section of the dam is approximately 20 feet wide on the top and has an earth slope on the wet side of approximately one foot on five feet. The earth slope on the face of the dam is approximately one foot on three feet.

During our visit to the site, we took several photographs and have numbered the reverse side of same for reference in this report.

The concrete spillway has a rectangular weir approximately 10 feet long with a wooden 2" by 6" set in the molded slots, as shown in Photos No. 3 and 4. There is approximately 2 1/2 feet of freeboard. There was no evidence whatsoever of any overtopping or danger thereof. The concrete spillway together with the cheek walls appear in very good condition and need little maintenance at present. The only recommended maintenance would be to rechink some of the stone steps, as evidenced in Photo No. 5. In addition, the westerly end of the southerly wingwall is leaning forward from the construction joint westerly, as evidenced in Photo No. 6. It is my considered opinion that this section of the cheek wall should be removed and replaced in an upright position.

Do it

Next

575

It is our considered opinion that the dam at Plymouth Reservoir requires attention at this time. While we do not feel that structural failure of the dam is imminent, we do feel that certain symptoms evident at this time require further investigation. As indicated on the plan accompanying this report, there are several spongy areas between the dam and the North Street pavement. These spongy areas exist both to the north and south of the spillway. In addition to this, there is water coming through the pavement as indicated on the sketch and running into the open ditch adjacent to the pavement. There are several ways available for curing these deficiencies; however, further investigation must take place in order to ascertain which remedy would be most economical. In the event that valves and piping are available to lower the level of the reservoir, it would be most advantageous to take corrective steps on the back of the dam rather than on the face. Additional investigation would reveal if this possibility exists.

We hereby recommend that the owner of the dam authorize an investigation in the very near future in order that the preventive maintenance can be completed prior to additional deterioration and possible future failure.

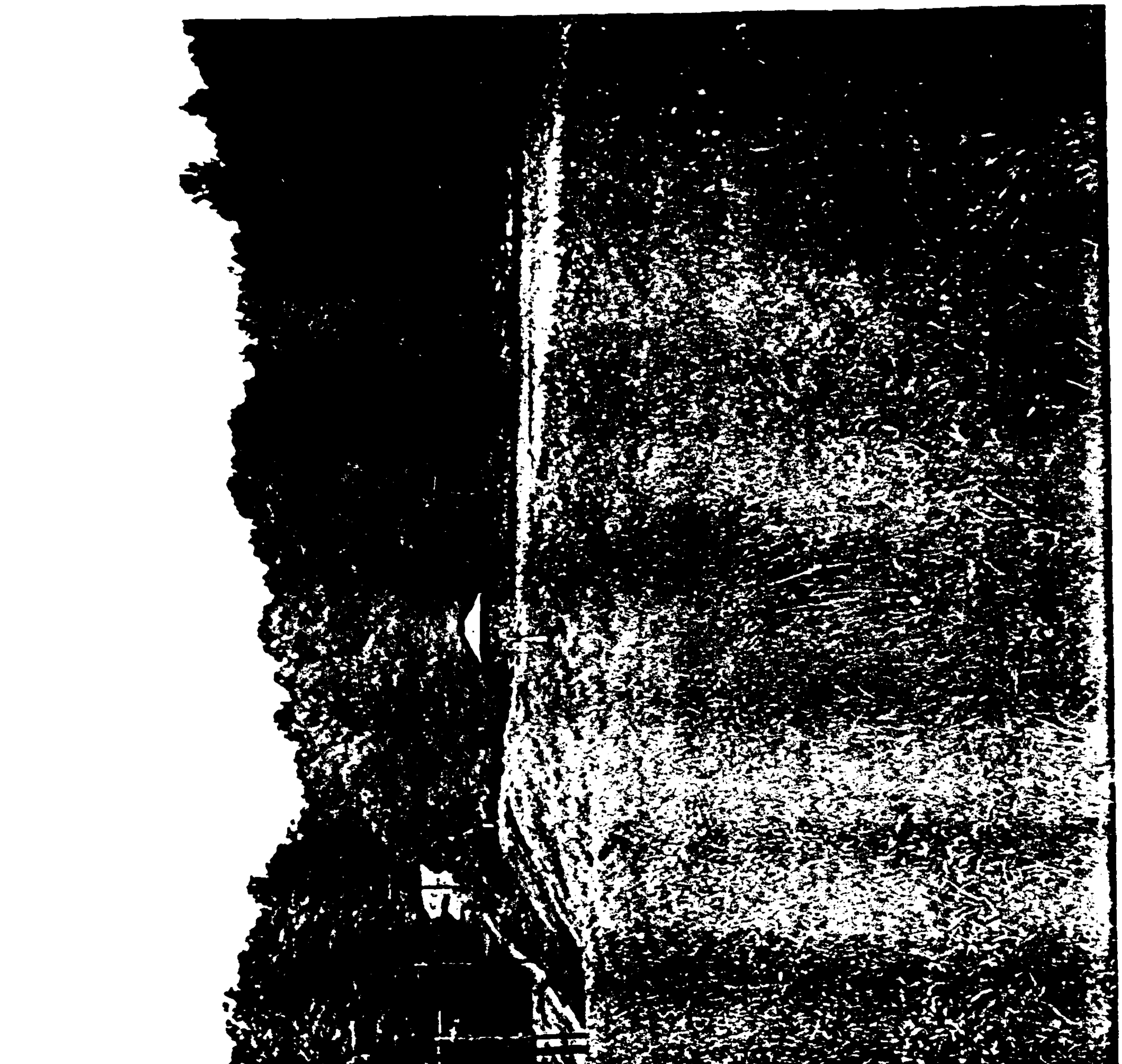
Respectfully submitted,

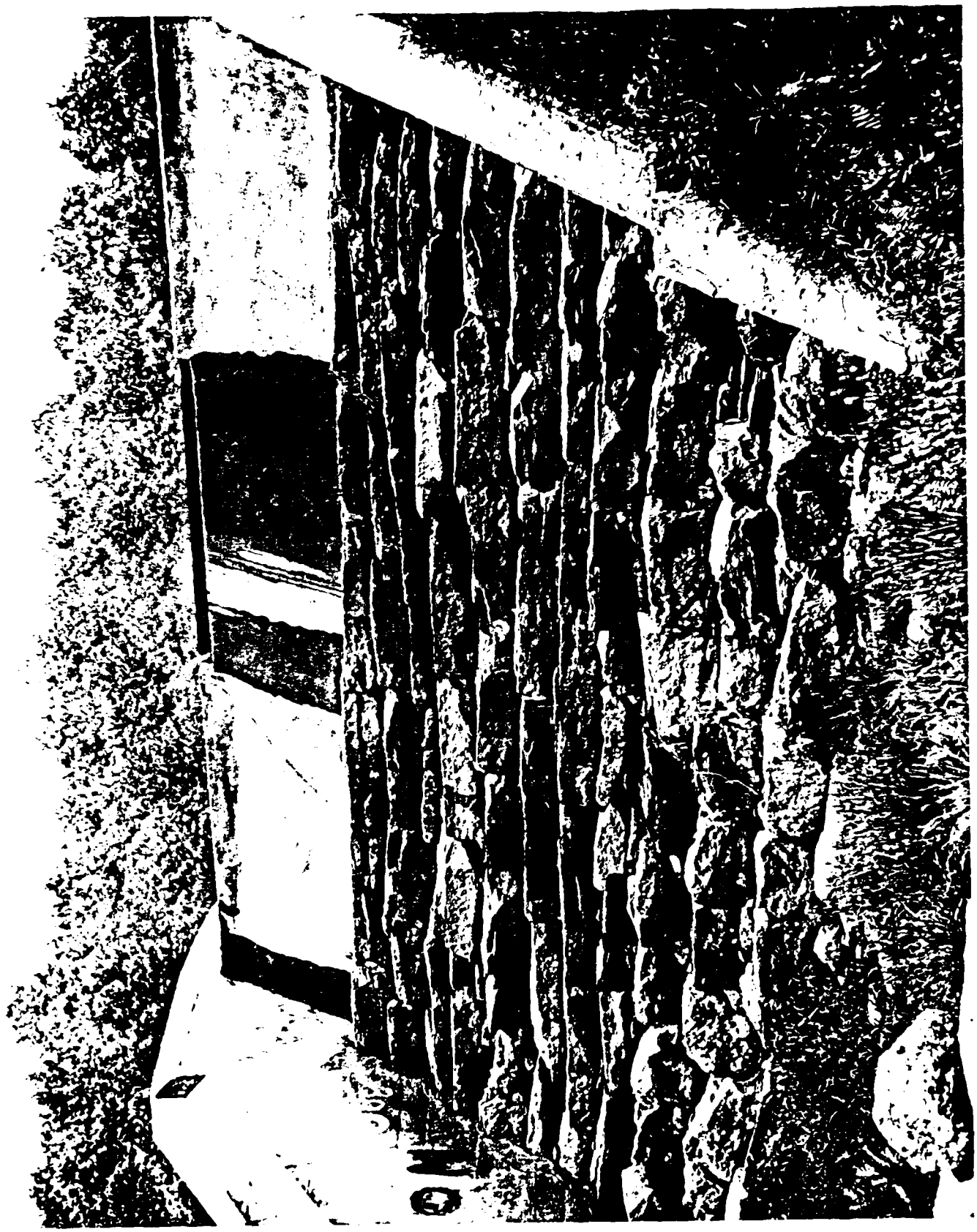
S. E. MINOR & CO., INC.

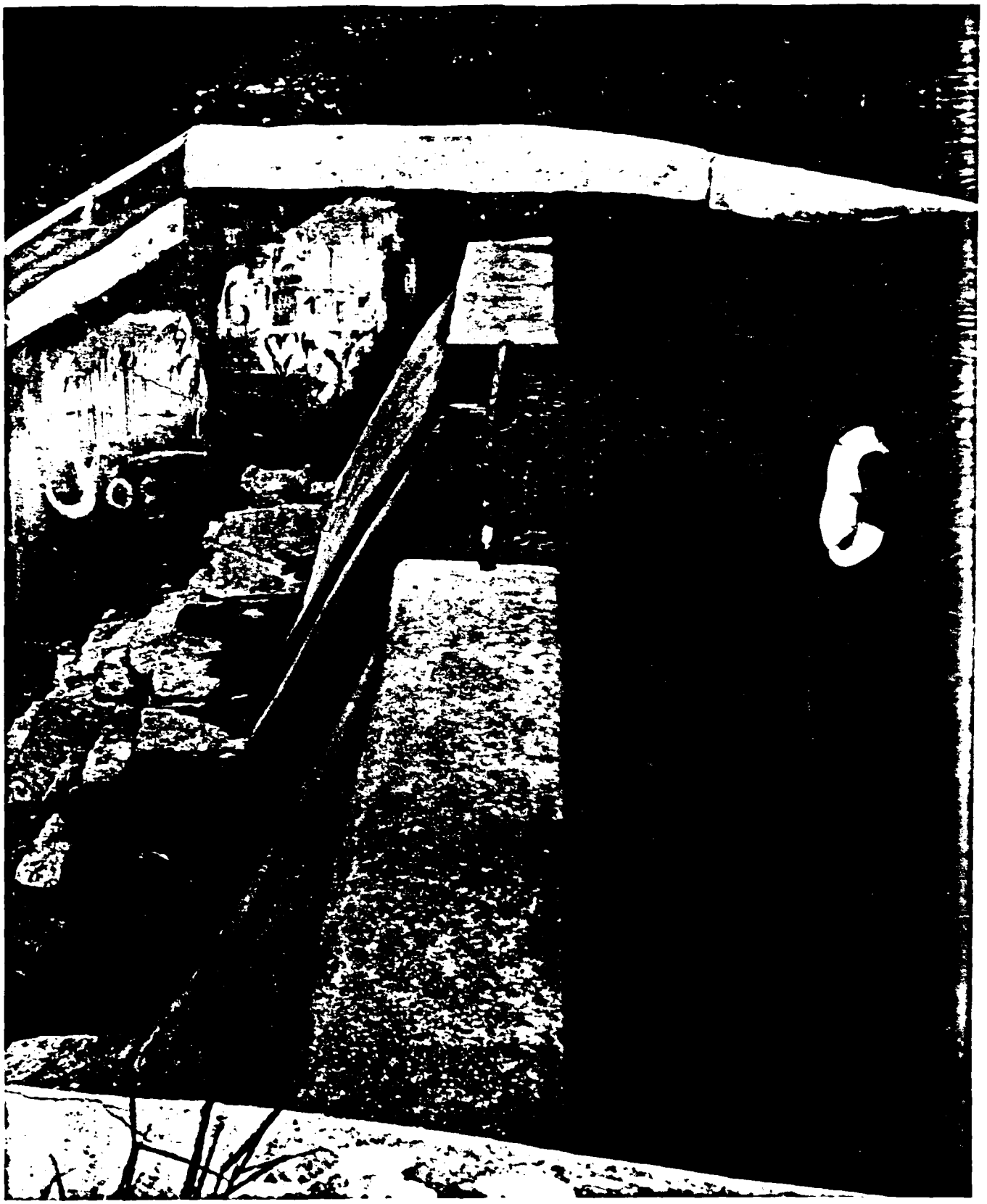
Edward F. Ahneman, Jr.

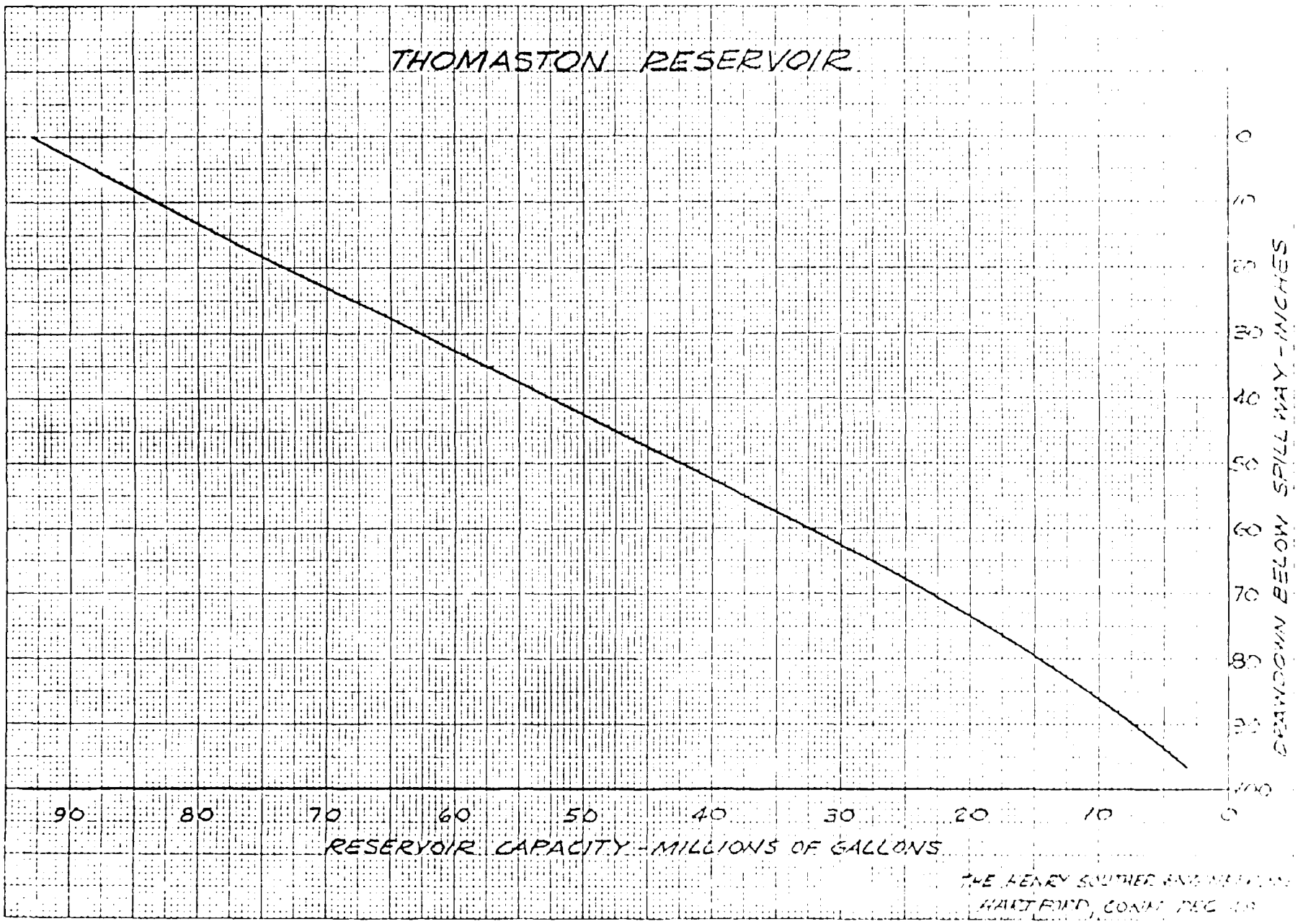
Edward F. Ahneman, Jr.
Chief Engineer

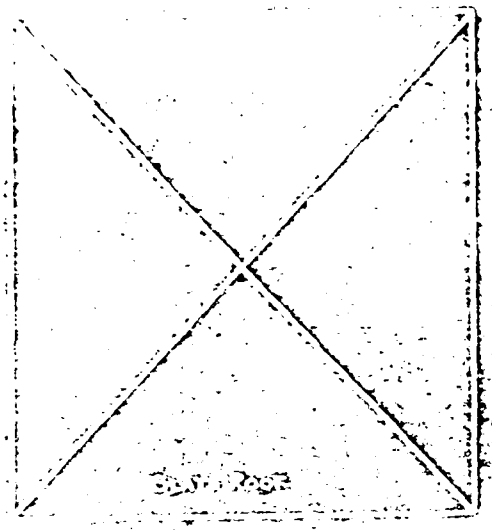
EFA:lb

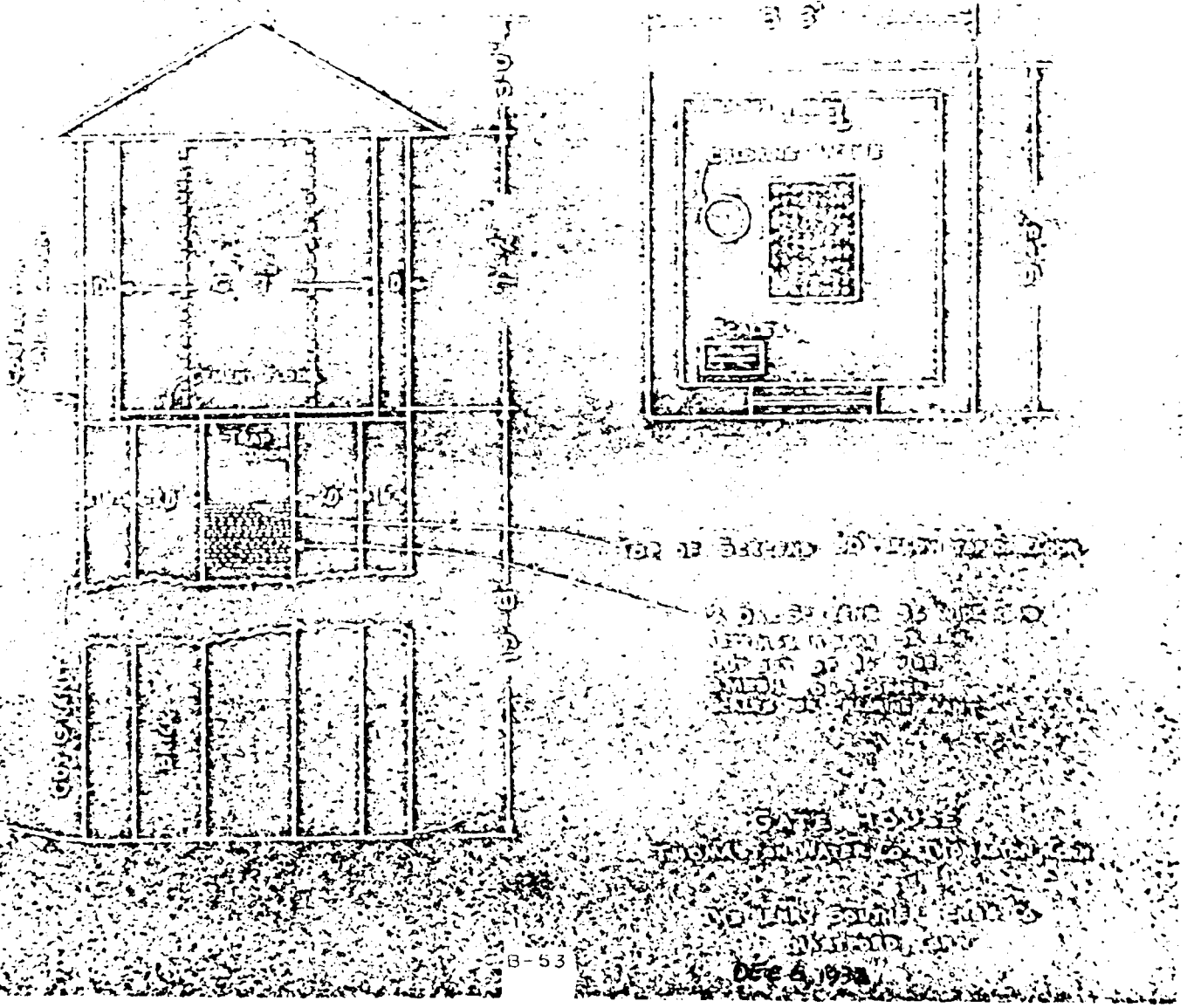




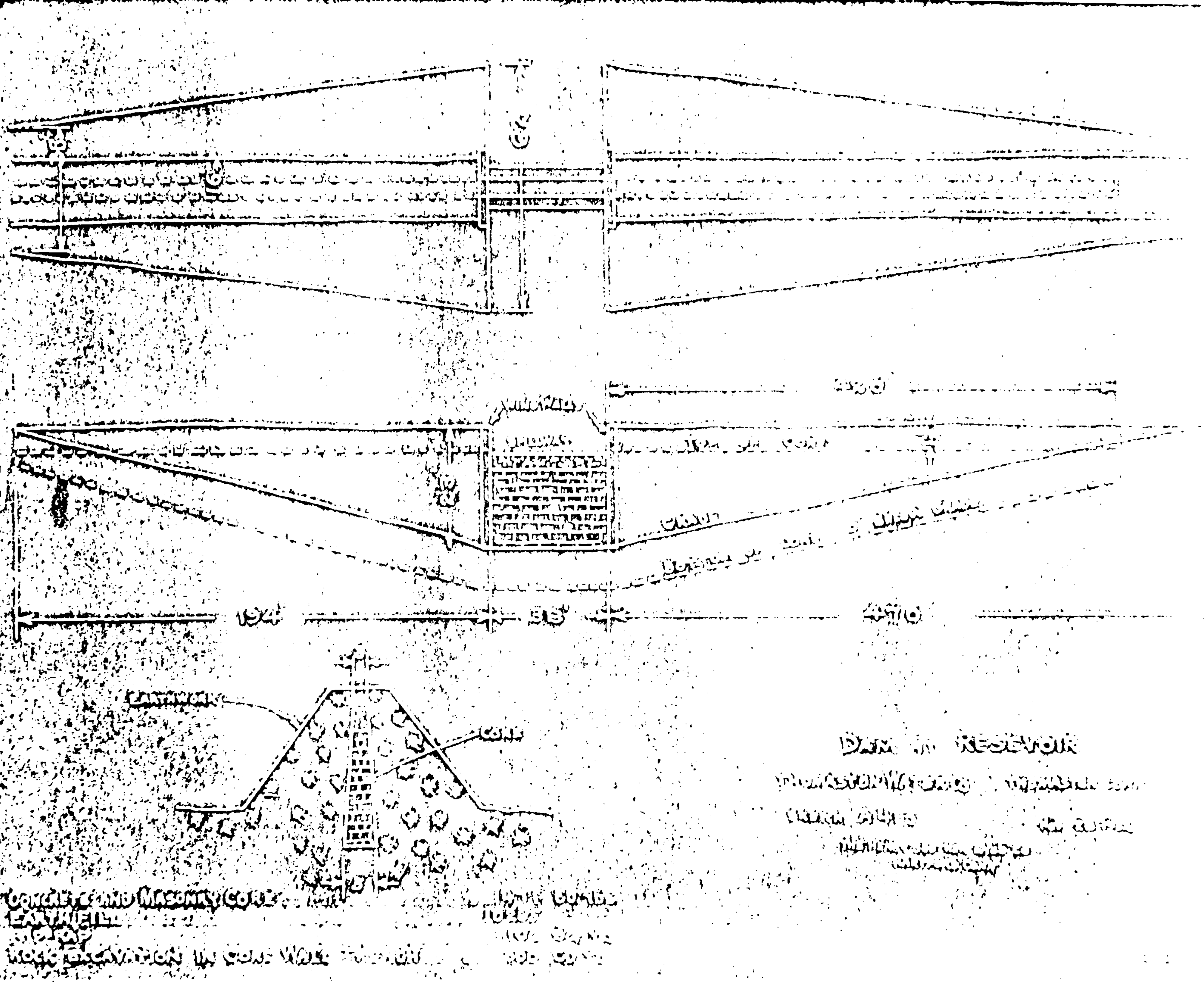



THOMASTON RESERVOIR
DRAWDOWN BELOW SPILL WAY - INCHES
0
10
20
30
40
50
60
70
80
90
100
90
80
70
60
50
40
30
20
10
0
RESERVOIR CAPACITY - MILLIONS OF GALLONS





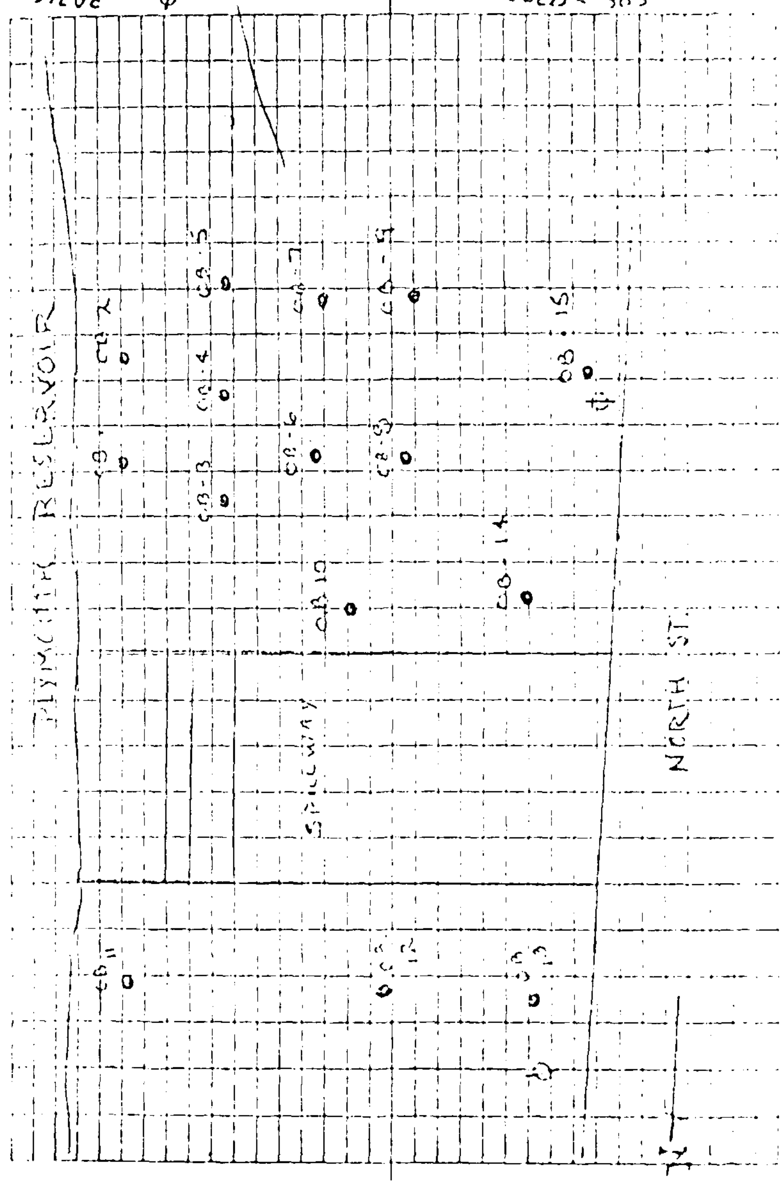
Dec 6, 1938

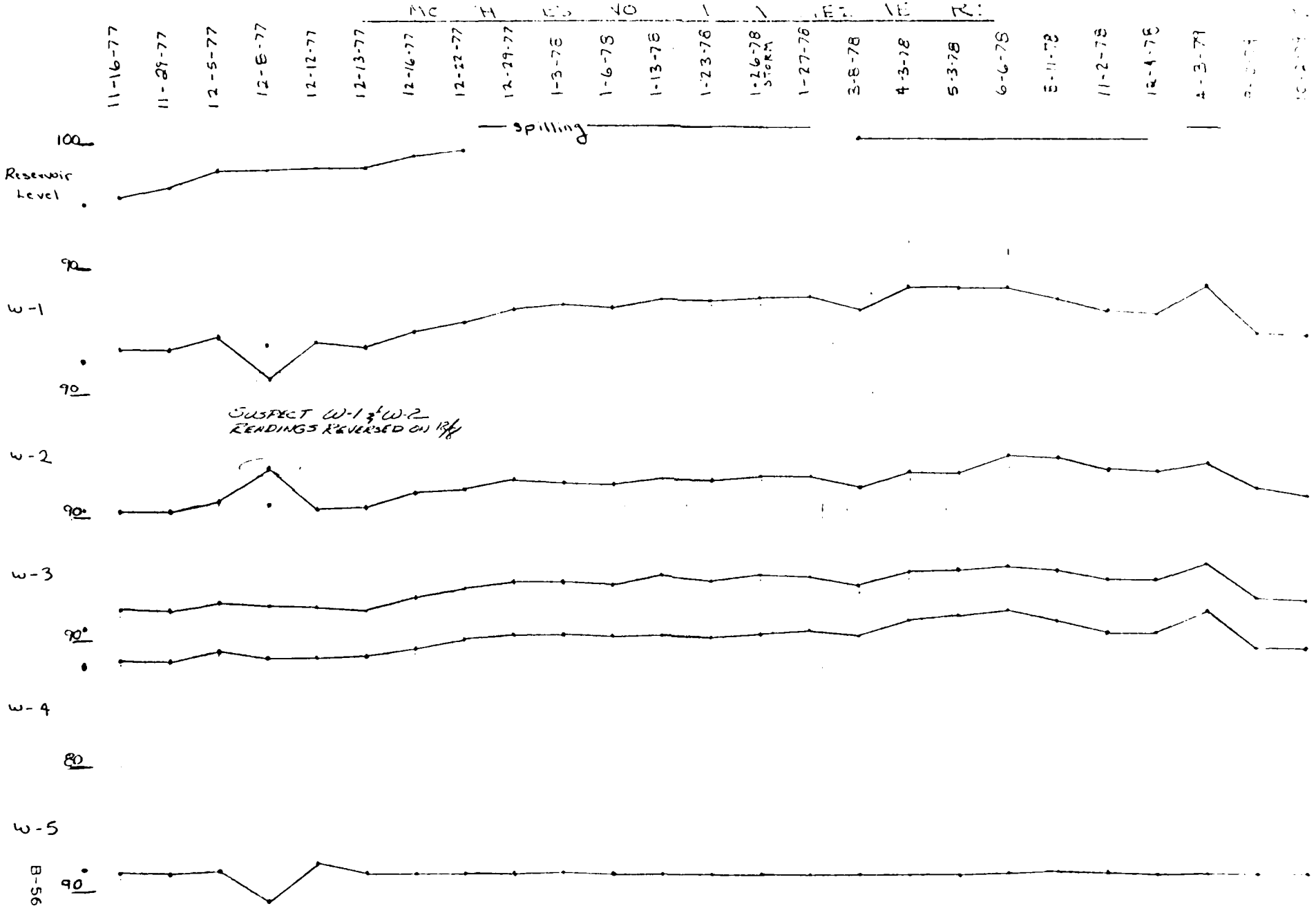

194
55
470
EARTHWORK
CORE
DAM ... RESERVOIR
CONCRETE AND MASONRY CORE
EARTHFILL
RIPRAP
ROCK EXCAVATION IN CORE WALL

PLYMOUTH RESERVOIR DAM
ELEVATIONS - TOP OF TEST WELLS

B.M.	B.S.	H.I.	F.S.	ELEV.
BM # 5				94.29
Gusset S.W. on clip # ...	9.73	104.02		
O.B. # 13			11.45	92.60
O.B. # 12			8.77	95.25
O.B. # 11			0.74	103.28
O.B. # 6			6.35	97.67
O.B. # 7			6.26	97.76
O.B. # 8			11.66	92.76
O.B. # 9			11.45	92.57
O.B. # 10			9.76	94.26
O.B. # 14			12.88	91.14
CHECK OF SETTLEMENT MARKER				
BM # 5				
S.W. SM # 1			8.90	95.12
S.E. SM # 2			3.36	100.66
N.W. SM # 3			7.33	96.69
N.E. SM # 4			3.64	100.38
O.B. # 15			13.45	90.57
Check in			9.73	
... south ... 3 ...			9.71	94.31

Rulkus (?)
Silve
11/24/77
Cold - 30's
4




11-16-77
11-29-77
12-5-77
12-8-77
12-12-77
12-13-77
12-16-77
12-22-77
12-29-77
1-3-78
1-6-78
1-13-78
1-23-78
1-26-78 STORM
1-27-78
3-8-78
4-3-78
5-3-78
6-6-78
8-11-78
11-2-78
12-4-78
4-3-79
spilling
Reservoir Level
100
90
W-1
90
SUSPECT W-1 & W-2 READINGS REVERSED ON 12/8
W-2
90
W-3
90
W-4
80
W-5
90
B-56

W-6
W-7
W-8
W-9
W-10
W-11
80
BROKEN
DRY
11-16-77
11-29-77
12-5-77
12-6-77
12-12-77
12-13-77
12-16-77
12-22-77
12-29-77
1-3-78
1-6-78
1-13-78
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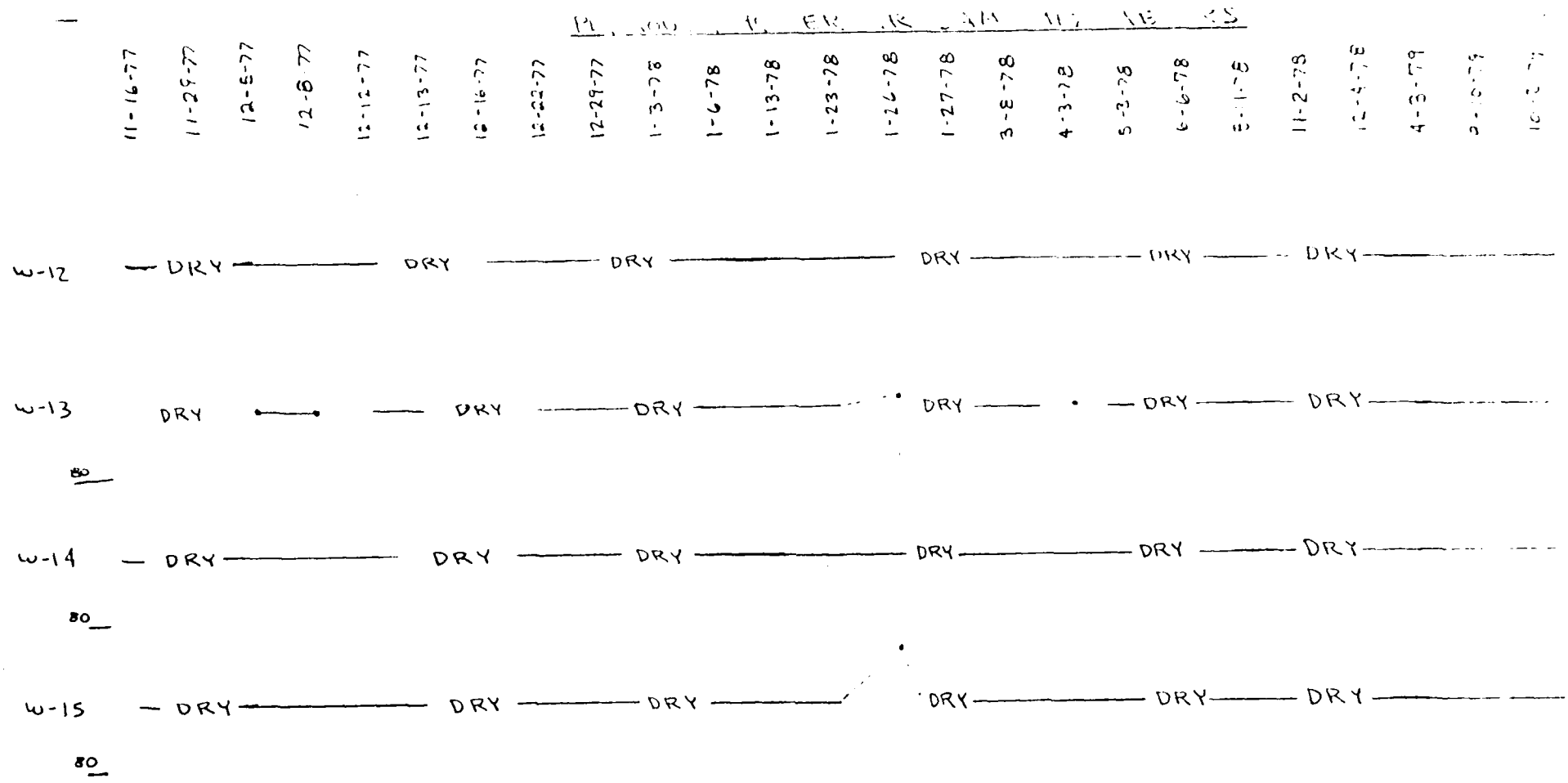
5-3-78
6-6-78
11-2-78
4-3-79


11-16-77
11-29-77
12-5-77
12-8-77
12-12-77
12-13-77
12-16-77
12-22-77
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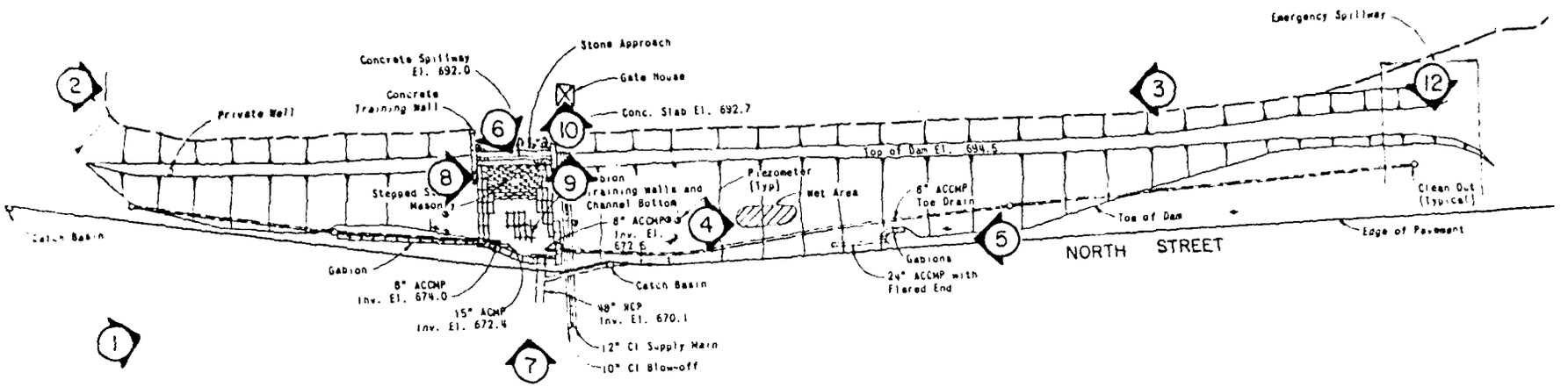
1-3-78
1-6-78
1-13-78
1-23-78
1-26-78
1-27-78
3-8-78
4-3-78
5-3-78
6-6-78
11-2-78
4-3-79
W-12
DRY
DRY
DRY
DRY
DRY
DRY
W-13
DRY
DRY
DRY
DRY
DRY
DRY
80
W-14
DRY
DRY
DRY
DRY
DRY
DRY
80
W-15
DRY
DRY
DRY
DRY
DRY
DRY
80

APPENDIX C

PHOTOGRAPHS

FIGURE 3

PLYMOUTH RESERVOIR



(11) TAKEN AT OUTLET END OF BLOWOFF

(N) INDICATES PHOTO NUMBER AND DIRECTION IN WHICH PHOTO WAS TAKEN

ROALD HAESTAD, INC CONSULTING ENGINEERS WATERBURY, CONNECTICUT	U.S. ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

PHOTO LOCATION PLAN
PLYMOUTH RESERVOIR DAM
PLYMOUTH, CONNECTICUT

DRAWN	CHECKED	APPROVED	SCALES	PAGE
JRS	RJL	RH	1" = 8'	
			DATE 5/91	

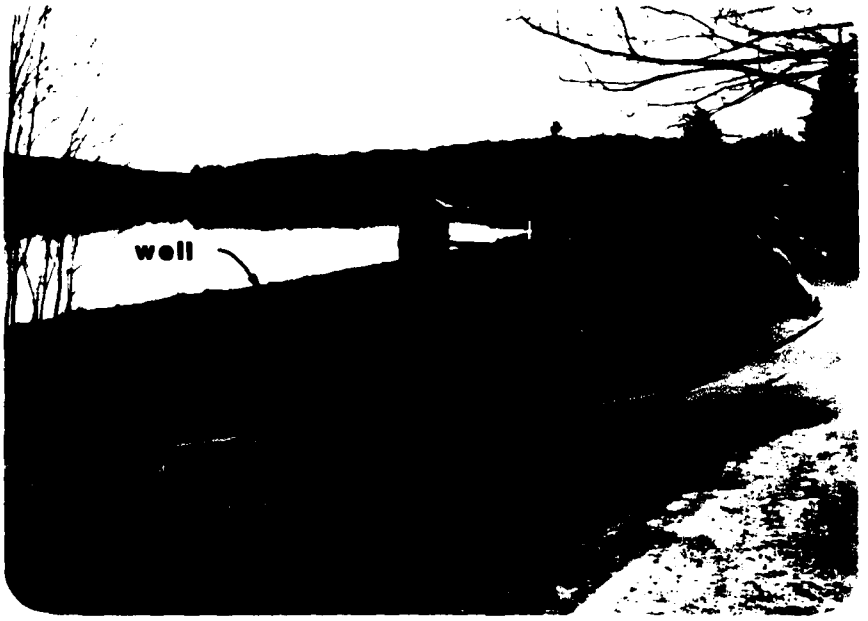


PHOTO NO. 1

DAM FROM RIGHT ABUTMENT. NOTE WELL AT RIGHT END OF CREST AND STONE FILLED GABIONS AT DOWNSTREAM TOE AND SPILLWAY.

PHOTO NO. 2

CREST AND UPSTREAM SLOPE FROM RIGHT ABUTMENT. NOTE LACK OF RIPRAP ABOVE WATER LEVEL.

U S ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	PLYMOUTH RESERVOIR DAM TRIB. TO NAUGATUCK RIV. PLYMOUTH, CONNECTICUT CT 00286 28 APRIL '81
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		

PHOTO NO. 3

UPSTREAM SLOPE AND CREST. NOTE LACK OF RIPRAP ABOVE WATERLINE AND TIRE PATHS ON CREST.

PHOTO NO. 4

WET AREA ON DOWNSTREAM SLOPE.

U S ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	PLYMOUTH RESERVOIR DAM TRIB. TO NAUGATUCK RIV. PLYMOUTH, CONNECTICUT CT 00286 28 APRIL '81
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		

PHOTO NO. 5

SEEPAGE AT EDGE OF ROAD NEAR LEFT END OF DAM. FLOW AT DOWNSTREAM END OF PIPE APPROXIMATELY 1 GPM.

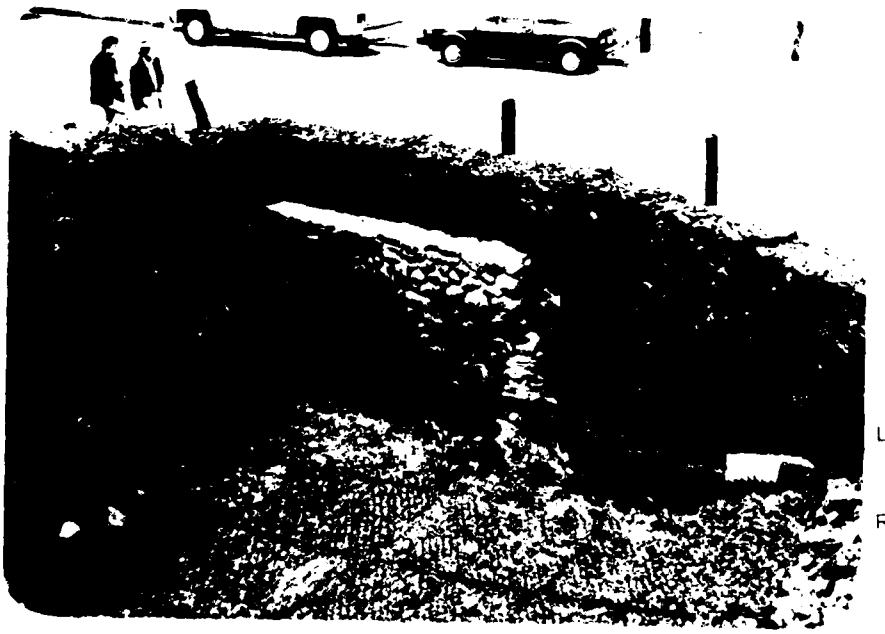


PHOTO NO. 6

STONE GABIONS AND STONE MAT AT END OF SPILLWAY DISCHARGE CHANNEL. NOTE 48" CULVERT UNDER ROAD, 8" ACCMP OUTLETS FOR TOE DRAIN AT LEFT AND RIGHT, AND 15" CMP DRAIN AT RIGHT. FLOW IN 15"CMP DRAIN APPROXIMATELY 5 GPM.

U S ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	PLYMOUTH RESERVOIR DAM TRIB. TO NAUGATUCK RIV. PLYMOUTH, CONNECTICUT CT 00286 28 APRIL '81
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		

PHOTO NO. 7

SPILLWAY FROM DOWNSTREAM. NOTE STONE MASONRY BELOW CONCRETE WEIR.

PHOTO NO. 8

LEFT SPILLWAY TRAINING WALL. NOTE REDUCTION OF SPILLWAY LENGTH DUE TO LOCATION OF GABIONS INSIDE OF CONCRETE TRAINING WALLS.

US ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	PLYMOUTH RESERVOIR DAM TRIB. TO NAUGATUCK RIV. PLYMOUTH, CONNECTICUT CT 00286 28 APRIL '81
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		

PHOTO NO. 9

GATEHOUSE

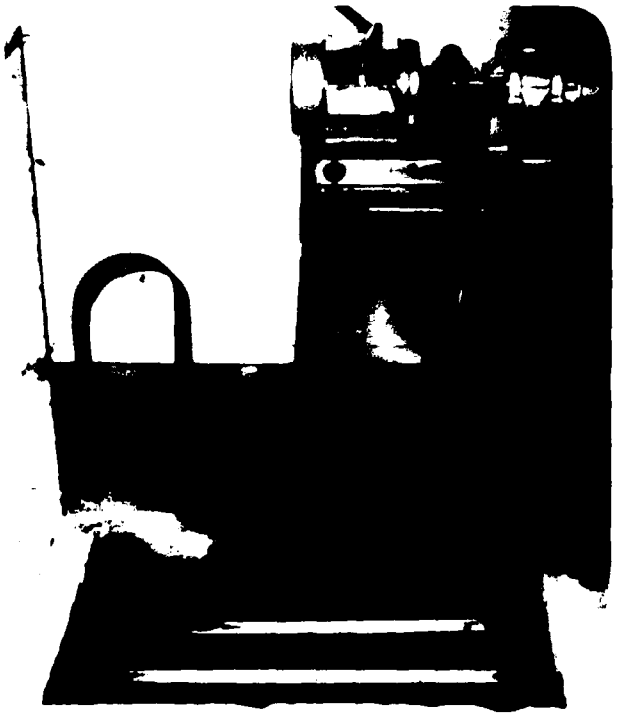


PHOTO NO. 10

INSIDE OF GATEHOUSE. NOTE SCREEN CHAMBER, HAND WHEEL GATE OPERATORS AND COMPRESSOR FOR AERATION SYSTEM.

US ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	PLYMOUTH RESERVOIR DAM TRIB. TO NAUGATUCK RIV. PLYMOUTH, CONNECTICUT CT 00286 28 APRIL '81
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		

PHOTO NO. 11

OUTLET END OF 1 INCH DIA. G.I.
UPPER & L. LEAD PIPES ARE FROM TREATMENT PLANT ON L. A. DAM.

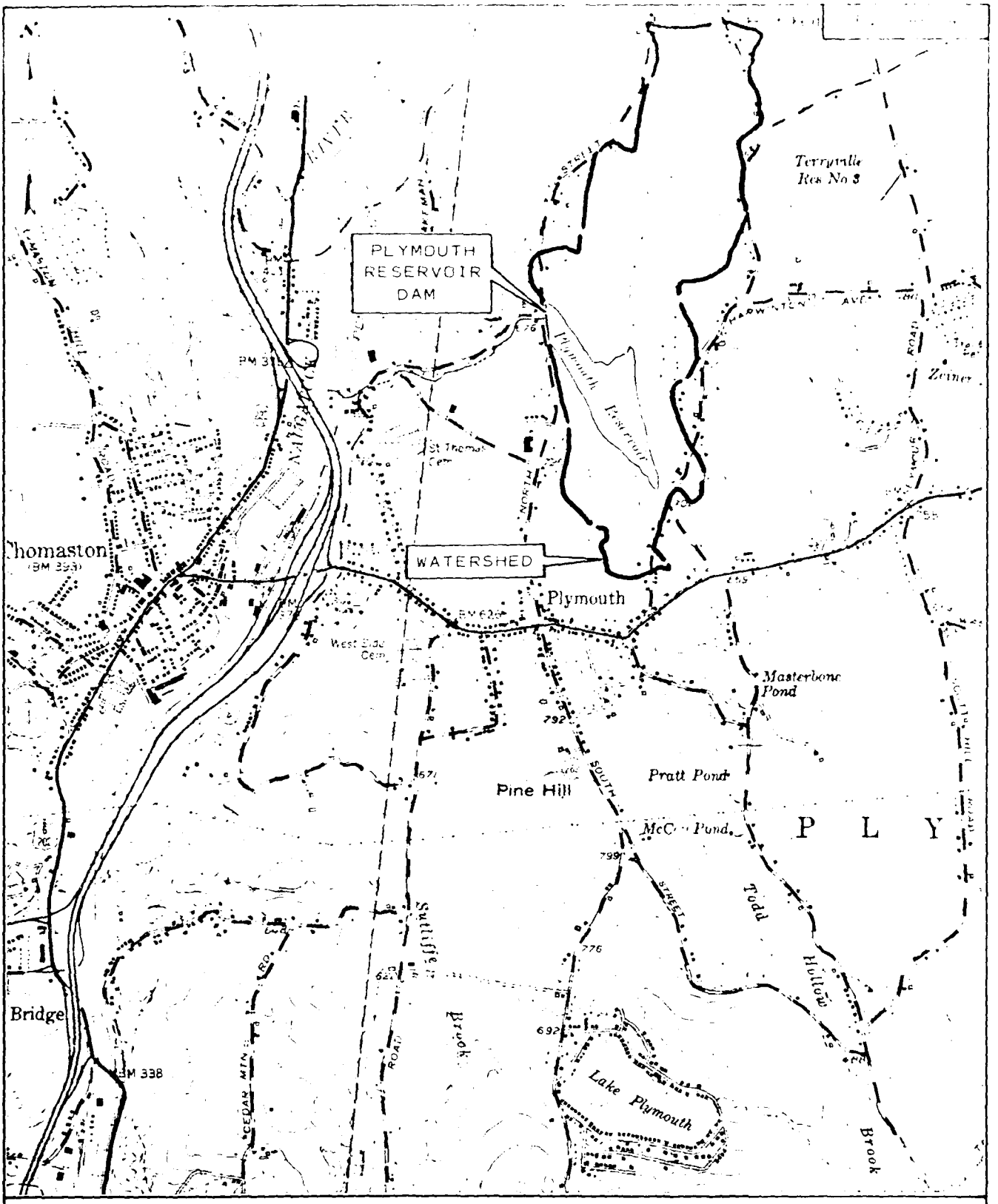
PHOTO NO. 12

EMERGENCY SPILLWAY AT LEFT END OF DAM.
NOTE MANHOLE FOR THE DRAIN.

U S ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	PLYMOUTH RESERVOIR DAM TRIB. TO NAUGATUCK RIV. PLYMOUTH, CONNECTICUT 28 APRIL '81
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS



WATERSHED MAP

PLYMOUTH RESERVOIR DAM
PLYMOUTH, CONNECTICUT

SCALE: 1" = 2000'

ROALD HAESTAD, INC. THOMASTON QUADRANGLE 1969

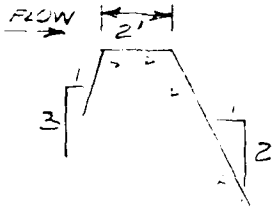
BY ..... DATE 7/29/81 **ROALD HAESTAD, INC.** SHEET NO ..... OF .....

CONSULTING ENGINEERS

CKD BY ..... DATE 7/29/81 37 Brookside Road - Waterbury, Conn 06708 JOB NO .....

SUBJECT PLYMOUTH RESERVOIR DAM - Project discharge capacity

Spillway Section: (Scale 1"=5' V≠H)

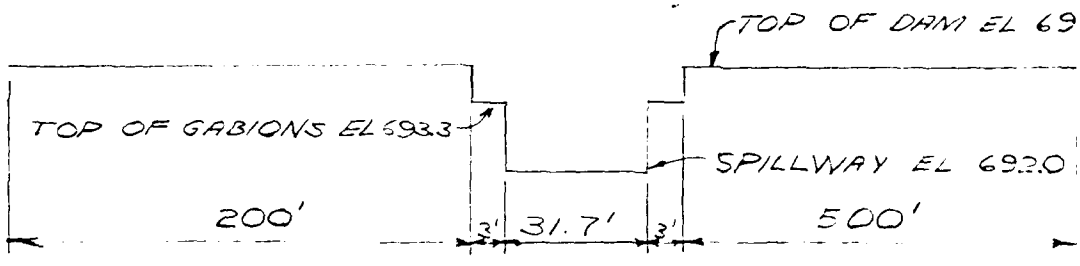


L = 31.7 feet

C = 3.1

$Q = CLH^{3/2}$

Dam Profile: (Not to scale)



Dam Embankment discharge coeff. = 2.7
Gabions discharge coefficient = 2.5

Elev. (feet)	Discharge Capacity - cfs			Total Discharge Capacity - cfs
	Spillway	Gabions	Embankment	
692	0	0	0	0
693	98	0	0	98
694	278	9	0	278
694.5	388	20	0	708
695	511	33	668	1,212
696	786	67	3472	4,325
697	1099	107	7471	8,677

BY ..... DATE .....

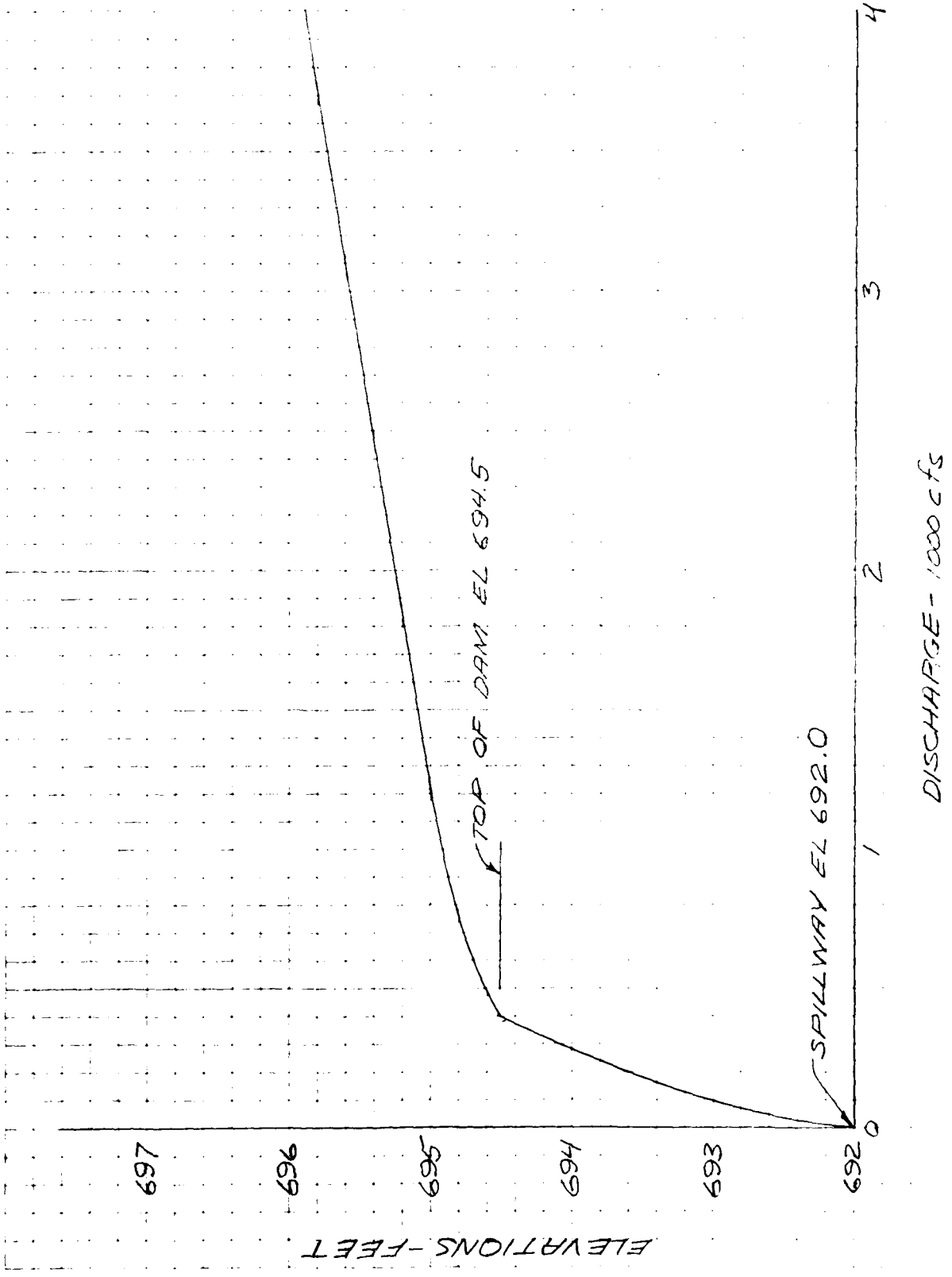
ROALD HAESTAD, INC.
CONSULTING ENGINEERS
37 Brookside Road - Waterbury, Conn. 06708

SHEET NO ..... OF .....

CKD BY ..... DATE .....

JOB NO .....

SUBJECT PLYMOUTH RESERVOIR DAM - Project discharge capacity.



BY ... DATE ... **ROALD HAESTAD, INC.** SHEET NO ... OF ...

CONSULTING ENGINEERS

CKD BY ... DATE ... 32 Brookside Road - Waterbury, Conn 06708 JOB NO ...

SUBJECT PLYMOUTH RES. DAM - Surcharge Storage Capacity

Elev (feet)	Surface Area (Acres)	Average Surface Area (Acres)	Surcharge Storage Cap (Ac-Ft)
692.0	36.7 *		0
		37.50	
693.0	38.3		38
		39.10	
694.0	39.9		77
		40.30	
694.5	40.7		97
		41.10	
695	41.5		117
		42.35	
696	43.2		160
		44.80	
698	46.4		249
		48.00	
700	49.6		345

* The surface area at spillway level was obtained from the Connecticut Water Co.

BY ..... DATE .....

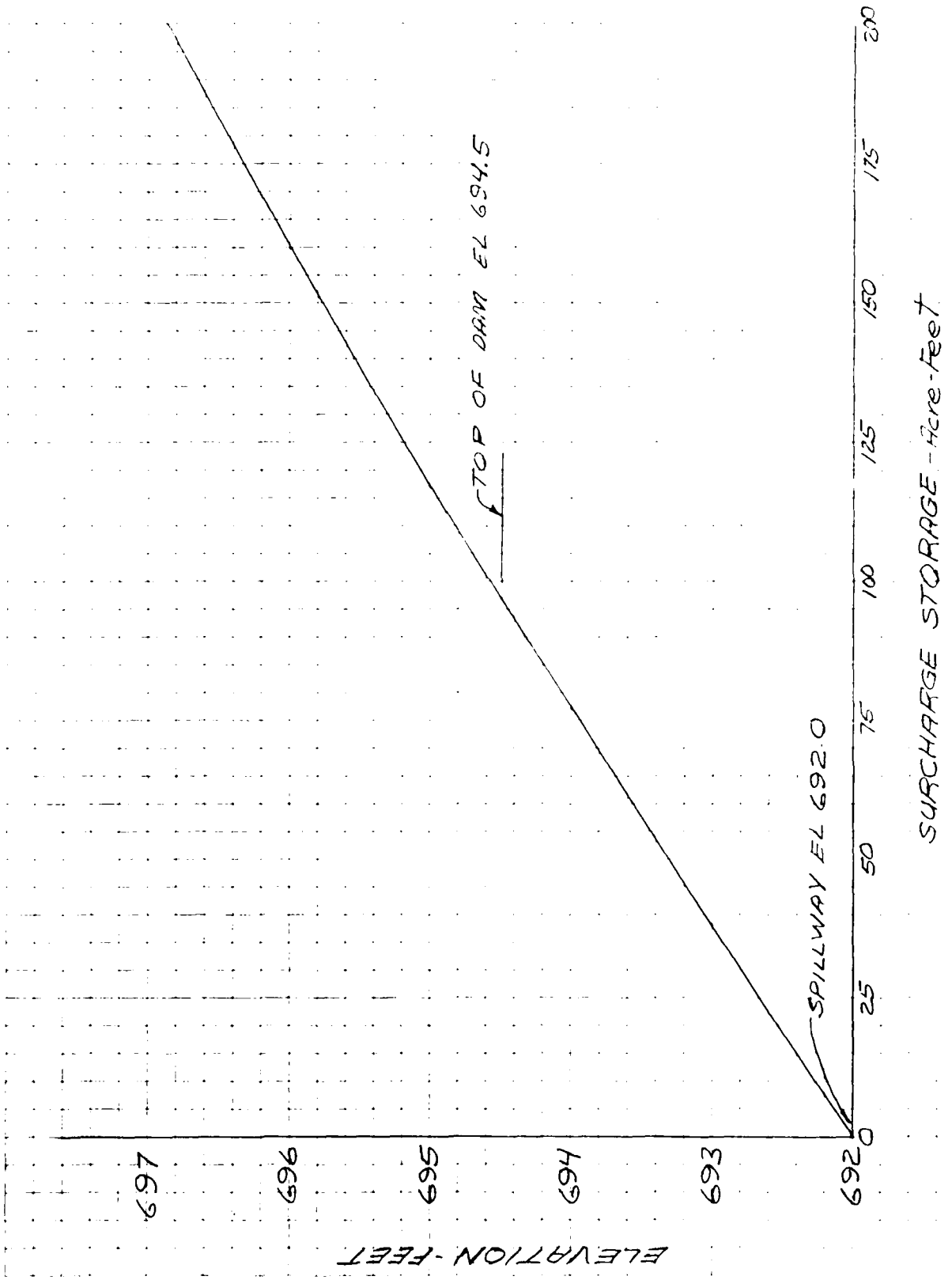
ROALD HAESTAD, INC.
CONSULTING ENGINEERS
37 Brookside Road - Waterbury Conn 06708

SHEET NO ..... OF .....

CKD BY ..... DATE .....

JOB NO .....

SUBJECT PLYMOUTH RESERVOIR DAM - Surcharge Storage Capacity



BY ..... DATE .....

ROALD HAESTAD, INC.
CONSULTING ENGINEERS
37 Brookside Road - Waterbury, Conn. 06708

SHEET NO ..... OF .....

CKD BY ..... DATE .....

JOB NO .....

SUBJECT PLYMOUTH RESERVOIR DAM - Test Flood

TEST FLOOD = 1/2 PMF

Drainage Area = 363 Acres = 0.57 square miles

Using Corps of Eng. chart for "Rolling" Terrain

MPF = 2,125 cfs/sq.mi. (2.0 sq mi Minimum)

PMF = 2,125 cfs/sq.mi. X 0.57 sq.mi. = 1,204 cfs

1/2 PMF = 1/2 (1,204 cfs) = 602 use 600 cfs

Q_{P1} = 600 cfs

H_1 = 2.7 ft, above spillway, from Discharge Curve

$STOR_1$ = 105 ac-ft, from Storage capacity curve

= 3.5" of runoff from 0.57 sq. mi.

Note: MPF Runoff in New England equals approximately 19". Therefore 1/2 PMF Runoff equals approximately 1/2(19) = 9.5".

$Q_{P2} = Q_{P1}(1 - STOR_1/9.5) = 600(1 - 3.5/9.5) = 379$ cfs

H_2 = 2.4 ft $STOR_2$ = 93 ac-ft

$STOR_{AVE} = (STOR_1 + STOR_2)/2 = (105+93)/2 = 99$ ac-ft
= 3.3' of runoff

$Q_{P3} = Q_{P1}(1 - STOR_{AVE}/9.5) = 600(1 - 3.3/9.5) = 391.6$ use 390 cfs

H_3 = 2.5 ft

Spillway discharge capacity = 408 cfs
(at top of dam)

% of Test Flood = (408/390) x100 = 104.6 use 105%
(1/2 PMF)

S = Storage at time of failure with water level at top of dam.

S = Storage at spillway level + Surcharge storage

$S = \left(95 \times 10^6 \text{ gal} \times \frac{1 \text{ ac-ft}}{325,851 \text{ gal}} \right) + 97$ Ac-Ft (From surcharge storage capacity curve)

S = 291.5 Ac-Ft + 97 Ac-Ft = 388.5 use 390 Ac-Ft

Note: The storage capacity at spillway level was obtained from the Connecticut Water Company.

Q_{pl} = Peak Failure Outflow = $8/27 \, W_b \sqrt{g} \, Y_o^{3/2}$

W_b = Breach width - 40% of dam length across river at mid height = 0.4(380) = 152 ft

Y_o = Total height from river bed to pool level at time of failure = 16 ft.

$Q_{pl} = 8/27 \, (152) \sqrt{32.2} \, (16)^{3/2}$

= 16,356 use 16,500 cfs

BY SAL DATE 7/1 83 FORD, BACON & DAVIS, INC. SHEET NO.

CKD BY DATE CONSULTING ENGINEERS OF NO.

SUBJECT PLYMOUTH RESERVOIR DAM-DEPTH OF FLOW

SECTION NUMBER 1

NORTH STREET

HEIGHT ABOVE INVERT (FEET)	D I S C H A R G E C A P A C I T Y CONDUIT (CFS)	SPILLWAY (CFS)	TOTAL (CFS)
1.0	12	0	12
2.0	24	0	24
3.0	52	0	52
4.0	80	0	80
5.0	105	0	105
6.0	130	0	130
7.0	146	0	146
8.0	162	0	162
9.0	179	0	179
10.0	195	313	507
11.0	208	884	1091
12.0	220	1899	2119
13.0	231	3278	3509
14.0	242	5148	5390
15.0	252	7429	7681
16.0	262	10231	10493
17.0	277	13478	13755
18.0	292	17285	17577
19.0	296	21577	21873
20.0	300	26456	26756

REACH OUTFLOW=QP2= 16500 CFS

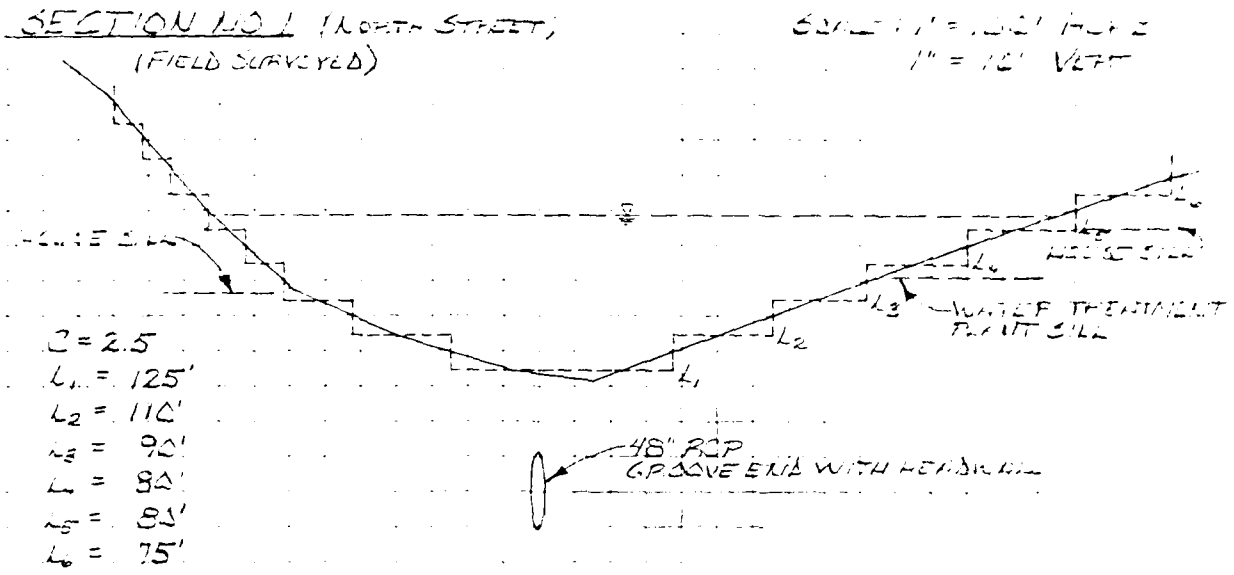
HEIGHT ABOVE CONDUIT INVERT=H2= 17.7 FT.

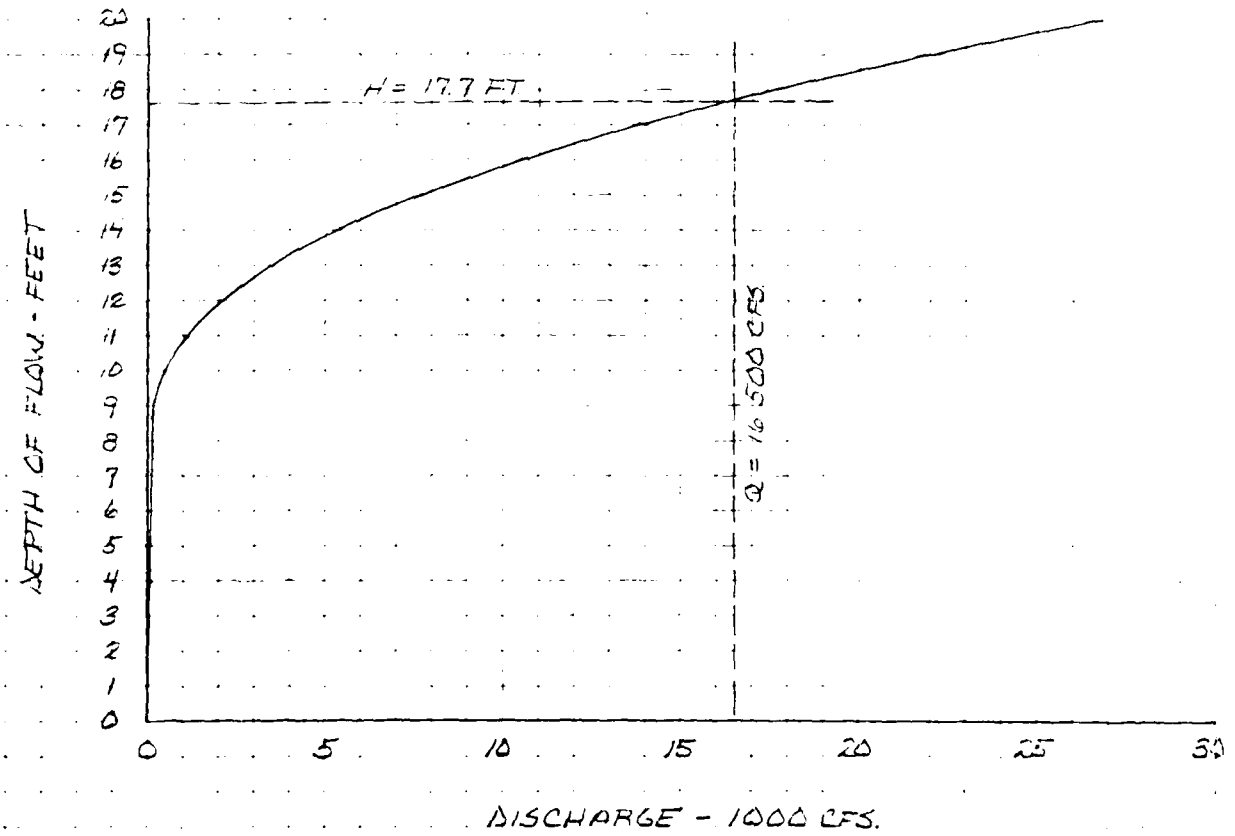
BY ..... DATE ..... **ROALD HAESTAD, INC.** SHEET NO ..... OF .....

CONSULTING ENGINEERS

CKD BY ..... DATE ..... 37 Brookside Road - Waterbury, Conn 06708 JOB NO .....

SUBJECT .....





BY SA DATE [illegible] ROALD HAESTAD, INC. SHEET NO. [illegible]

CKD BY [illegible] DATE 4/27/81 CONSULTING ENGINEERS JOB NO. [illegible]

SUBJECT PLYMOUTH RESERVOIR DAM-DEPTH OF FLOW

SECTION NUMBER 2A

MAIN CHANNEL

H (FT)	W (FT)	A (SQ-FT)	R (FT)	S (FT/FT)	V (FT/SEC)	Q (CFS)
1.0	11	9	0.81	0.0727	5.81	54
2.0	14	21	1.47	0.0727	8.64	181
3.0	17	35	2.03	0.0727	10.71	370
4.0	20	50	2.53	0.0727	12.40	620
5.0	23	67	2.99	0.0727	13.86	934
6.0	25	87	3.43	0.0727	15.18	1314
7.0	28	108	3.88	0.0727	16.49	1777
8.0	28	130	4.65	0.0727	18.61	2414
9.0	28	152	5.44	0.0727	20.66	3134
10.0	28	174	6.23	0.0727	22.61	3928
11.0	28	196	7.02	0.0727	24.48	4791
12.0	28	218	7.81	0.0727	26.28	5722
13.0	28	240	8.60	0.0727	28.02	6718
14.0	28	262	9.39	0.0727	29.71	7777
15.0	28	284	10.17	0.0727	31.35	8897
16.0	28	306	10.96	0.0727	32.96	10076
17.0	28	328	11.75	0.0727	34.52	11314
18.0	28	350	12.54	0.0727	36.05	12608
19.0	28	372	13.33	0.0727	37.54	13958
20.0	28	394	14.12	0.0727	39.01	15363

MANNING COEFFICIENT=N=0.0600

BY SAL DATE 5/15/81 DONALD HASTAD, INC. SHEET NO. 06

CHD BY [illegible] DATE [illegible] CONSULTING ENGINEERS JOB NO. 80-[illegible]

SUBJECT PLYMOUTH RESERVOIR DAM-DEPTH OF FLOW

SECTION NUMBER 2B

LEFT OVERBANK

H (FT)	W (FT)	A (SQ-FT)	R (FT)	S (FT/FT)	V (FT/SEC)	Q (CFS)
8.0	7	3	0.45	0.0727	2.93	10
9.0	16	15	0.94	0.0727	4.82	71
10.0	24	35	1.47	0.0727	6.47	223
11.0	27	60	2.20	0.0727	8.46	504
12.0	31	88	2.87	0.0727	10.11	891
13.0	34	120	3.50	0.0727	11.55	1387
14.0	38	156	4.10	0.0727	12.84	1996
15.0	42	194	4.68	0.0727	14.02	2726
16.0	45	237	5.25	0.0727	15.13	3582
17.0	49	283	5.80	0.0727	16.17	4569
18.0	52	332	6.35	0.0727	17.17	5696
19.0	72	394	5.46	0.0727	15.54	6116
20.0	74	465	6.30	0.0727	17.09	7945

MANNING COEFFICIENT=N=0.0800

SECTION NUMBER 2C

RIGHT OVERBANK

H (FT)	W (FT)	A (SQ-FT)	R (FT)	S (FT/FT)	V (FT/SEC)	Q (CFS)
7.0	2		0.10	0.0727	0.86	
8.0	11	7	0.60	0.0727	2.84	19
9.0	21	23	1.09	0.0727	4.25	96
10.0	30	48	1.59	0.0727	5.46	261
11.0	39	82	2.09	0.0727	6.55	540
12.0	49	126	2.59	0.0727	7.55	950
13.0	58	180	3.08	0.0727	8.49	1525
14.0	68	242	3.58	0.0727	9.38	2273
15.0	75	314	4.17	0.0727	10.38	3259
16.0	81	392	4.84	0.0727	11.46	4486
17.0	87	475	5.48	0.0727	12.45	5912
18.0	92	564	6.10	0.0727	13.38	7541
19.0	98	658	6.71	0.0727	14.26	9381
20.0	104	758	7.31	0.0727	15.09	11437

MANNING COEFFICIENT=N=0.1000

SUBJECT PLYMOUTH RESERVOIR DAM-DEPTH OF FLOW

SECTION NUMBER 2

TOTAL SECTION

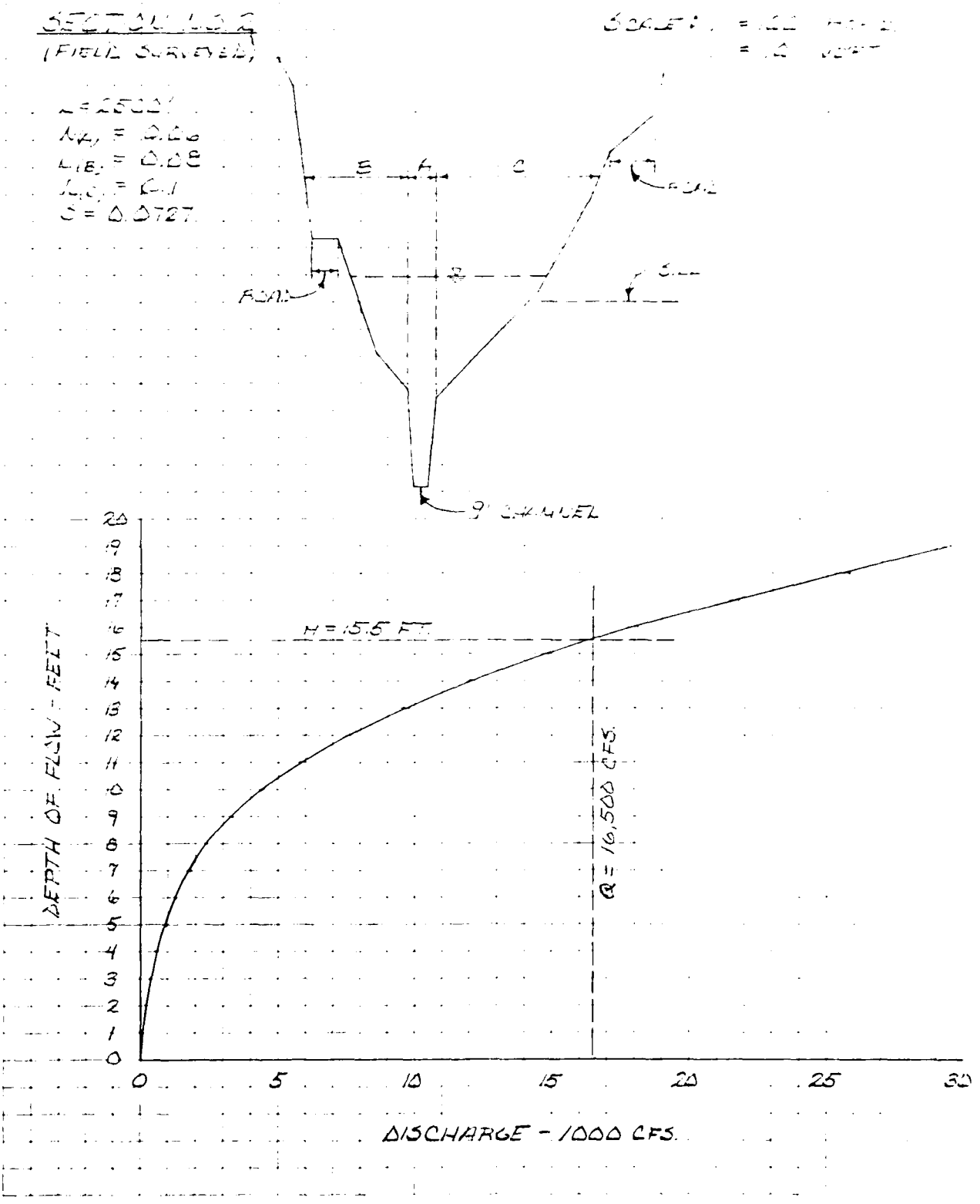
H	AREA (SQ.FT.) A	B	C	TOTAL	DISCHARGE (CFS) A	B	C	TOTAL
1.0	9	0	0	9	54	0	0	54
2.0	21	0	0	21	181	0	0	181
3.0	35	0	0	35	370	0	0	370
4.0	50	0	0	50	620	0	0	620
5.0	67	0	0	67	934	0	0	934
6.0	87	0	0	87	1314	0	0	1314
7.0	108	0	0	108	1777	0	0	1777
8.0	130	3	7	140	2414	10	19	2443
9.0	152	15	23	189	3134	71	96	3302
10.0	174	35	48	256	3928	223	261	4412
11.0	196	60	82	338	4791	504	540	5835
12.0	218	88	126	432	5722	891	954	7567
13.0	240	120	180	540	6718	1387	1525	9630
14.0	262	156	242	660	7777	1996	2273	12046
15.0	284	194	314	792	8897	2726	3259	14882
16.0	306	237	392	934	10076	3582	4486	18145
17.0	328	283	475	1085	11314	4569	5912	21795
18.0	350	332	564	1245	12608	5696	7541	25845
19.0	372	394	658	1423	13958	6116	9381	29454
20.0	394	465	758	1617	15363	7945	11437	34744

REACH OUTFLOW=QP2= 16500 CFS
DEPTH OF FLOW=H2= 15.5 FT.

ROALD HAESTAD, INC.

CONSULTING ENGINEERS

37 brookside Road - Waterbury, Conn. 06706



BY [illegible] DATE [illegible] [illegible]

CHD BY [illegible] DATE [illegible] [illegible]

SUBJECT PLYMOUTH RESERVOIR DAM-DEPTH OF FLOW

SECTION NUMBER 3

RAILROAD STREET

HEIGHT ABOVE INVERT (FEET)	D I S C H A R G E C A P A C I T Y CONDUIT (CFS)	SPILLWAY (CFS)	TOTAL (CFS)
1.0	19	0	19
2.0	38	0	38
3.0	73	0	73
4.0	108	0	108
5.0	135	0	135
6.0	162	0	162
7.0	184	0	184
8.0	205	0	205
9.0	223	288	510
10.0	240	813	1053
11.0	255	1606	1861
12.0	270	2618	2888
13.0	285	3799	4084
14.0	300	5125	5425
15.0	310	6670	6980
16.0	320	8406	8726
17.0	330	10301	10631
18.0	340	12337	12677
19.0	348	14655	15002
20.0	355	17219	17574

REACH OUTFLOW=QP2= 16500 CFS

HEIGHT ABOVE CONDUIT INVERT=H2= 19.6 FT.

BY ..... DATE .....

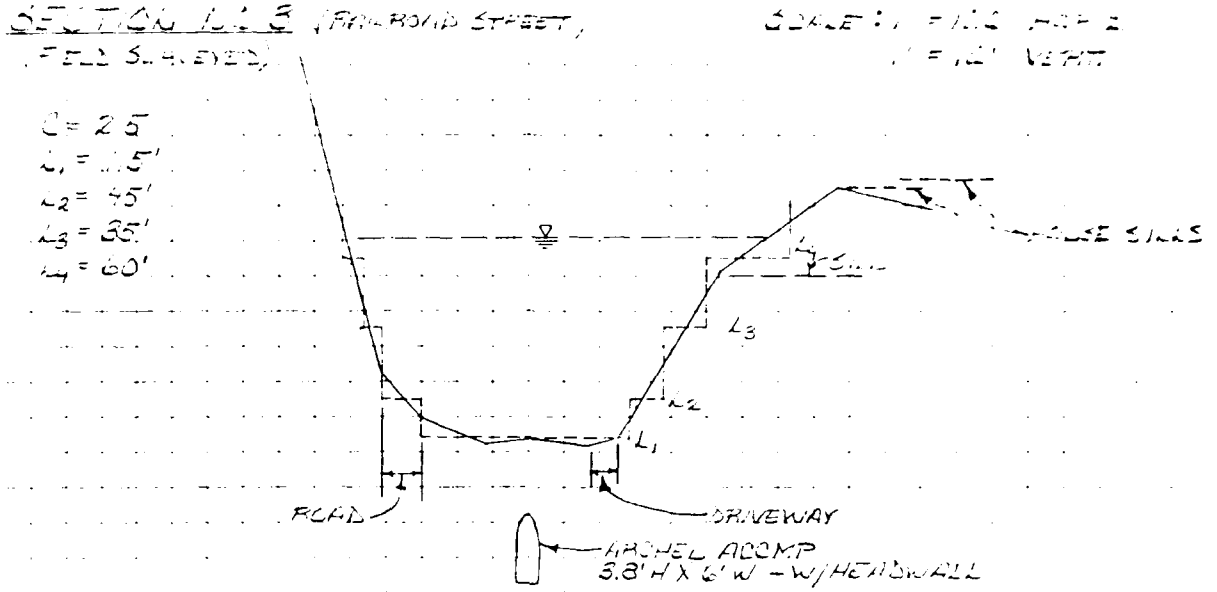
ROALD HAESTAD, INC.
CONSULTING ENGINEERS
37 Brookside Road - Waterbury, Conn. 06706

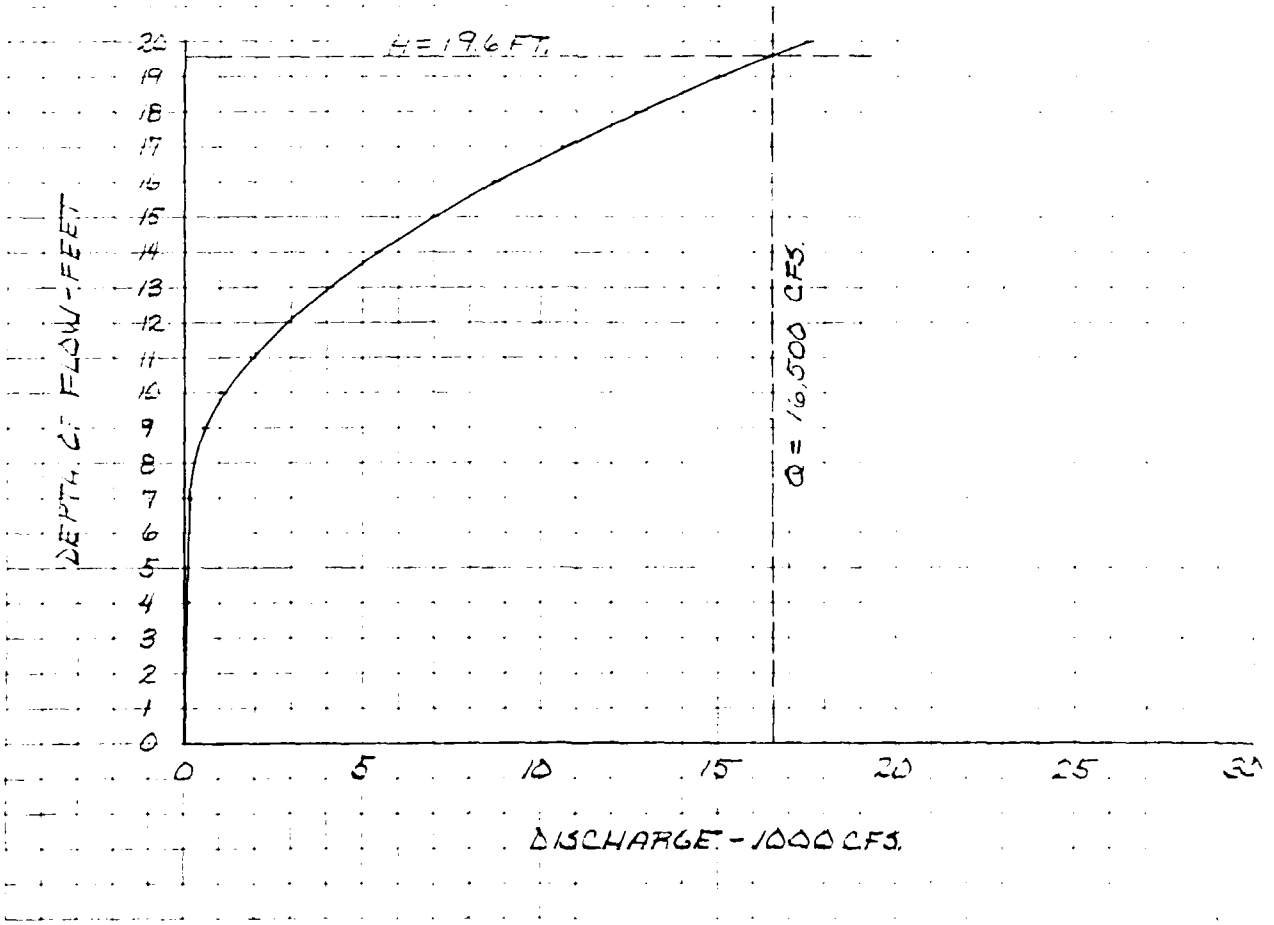
SHEET NO ..... OF .....

CKD BY ..... DATE .....

JOB NO .....

SUBJECT .....





SUBJECT PLYMOUTH RETENTION DAM-DEPTH OF FLOW

SECTION NUMBER 4

RAILROAD TRACKS

HEIGHT ABOVE INVERT (FEET)	DISCHARGE CONDUIT #1 (CFS)	CONDUIT #2 (CFS)	CONDUIT #3 (CFS)	CAPACITY SPILLWAY (CFS)	TOTAL (CFS)
1.0	14	0	12	0	26
2.0	28	0	24	0	52
3.0	59	0	48	0	107
4.0	90	0	72	0	162
5.0	123	0	92	0	215
6.0	155	0	113	0	268
7.0	179	0	128	0	306
8.0	203	0	142	0	345
9.0	226	0	155	0	381
10.0	250	77	168	0	495
11.0	266	155	179	0	600
12.0	283	233	190	0	705
13.0	299	310	198	0	807
14.0	315	457	206	0	978
15.0	329	604	214	0	1147
16.0	343	752	222	0	1316
17.0	356	899	232	0	1487
18.0	370	1081	241	0	1692
19.0	381	1263	251	0	1895
20.0	393	1445	260	0	2098
21.0	404	1628	266	0	2298
22.0	415	1802	273	0	2489
23.0	424	1976	279	0	2679
24.0	433	2151	285	0	2868
25.0	441	2325	289	0	3055
26.0	450	2461	293	2160	5363
27.0	462	2596	296	6109	9464
28.0	475	2732	300	11224	14731
29.0	487	2868	304	17280	20939
30.0	500	3003	308	24150	27960

REACH OUTFLOW=QP2= 16500 CFS

HEIGHT ABOVE CONDUIT INVERT=H2= 28.3 FT.

BY ..... DATE .....

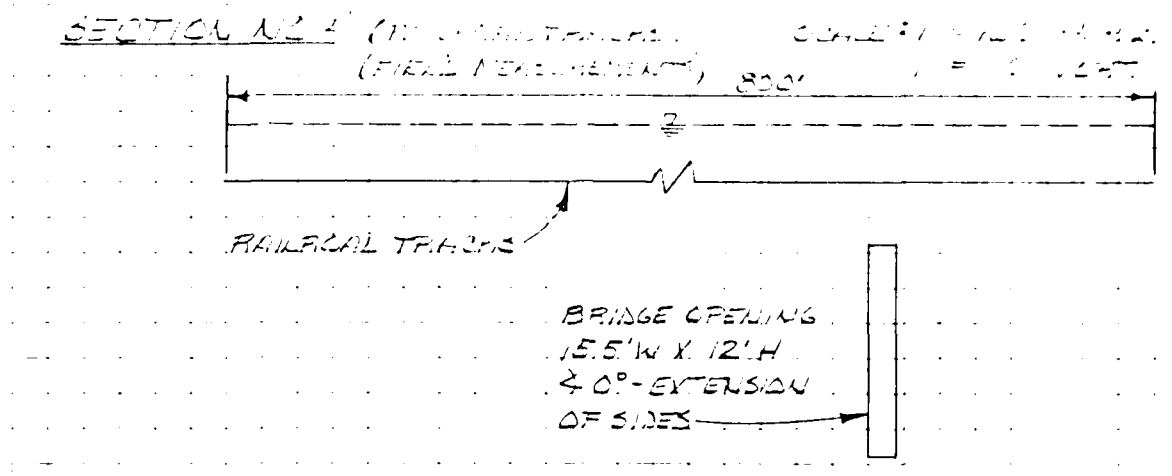
CKD BY ..... DATE .....

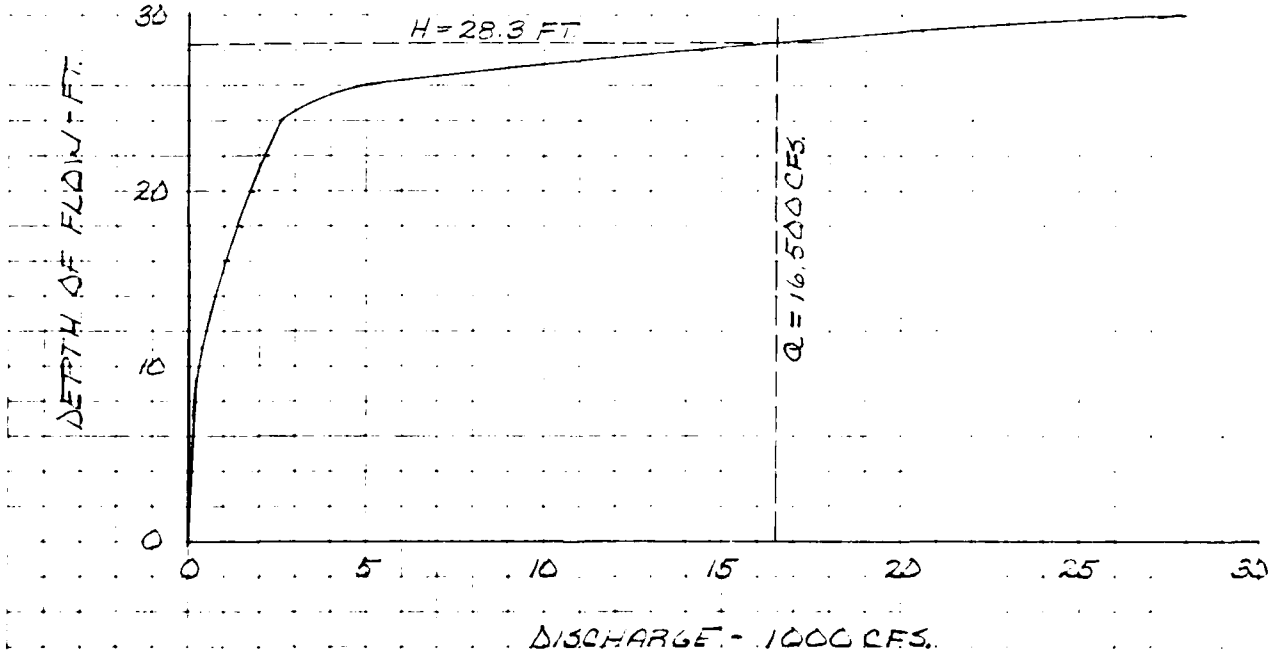
ROALD HAESTAD, INC.
CONSULTING ENGINEERS
37 Brookside Road - Waterbury, Conn. 06708

SHEET NO ..... OF .....

JOB NO .....

SUBJECT .....





BY ..... DATE ..... **ROALD HAESTAD, INC.** SHEET NO ..... OF .....

CONSULTING ENGINEERS

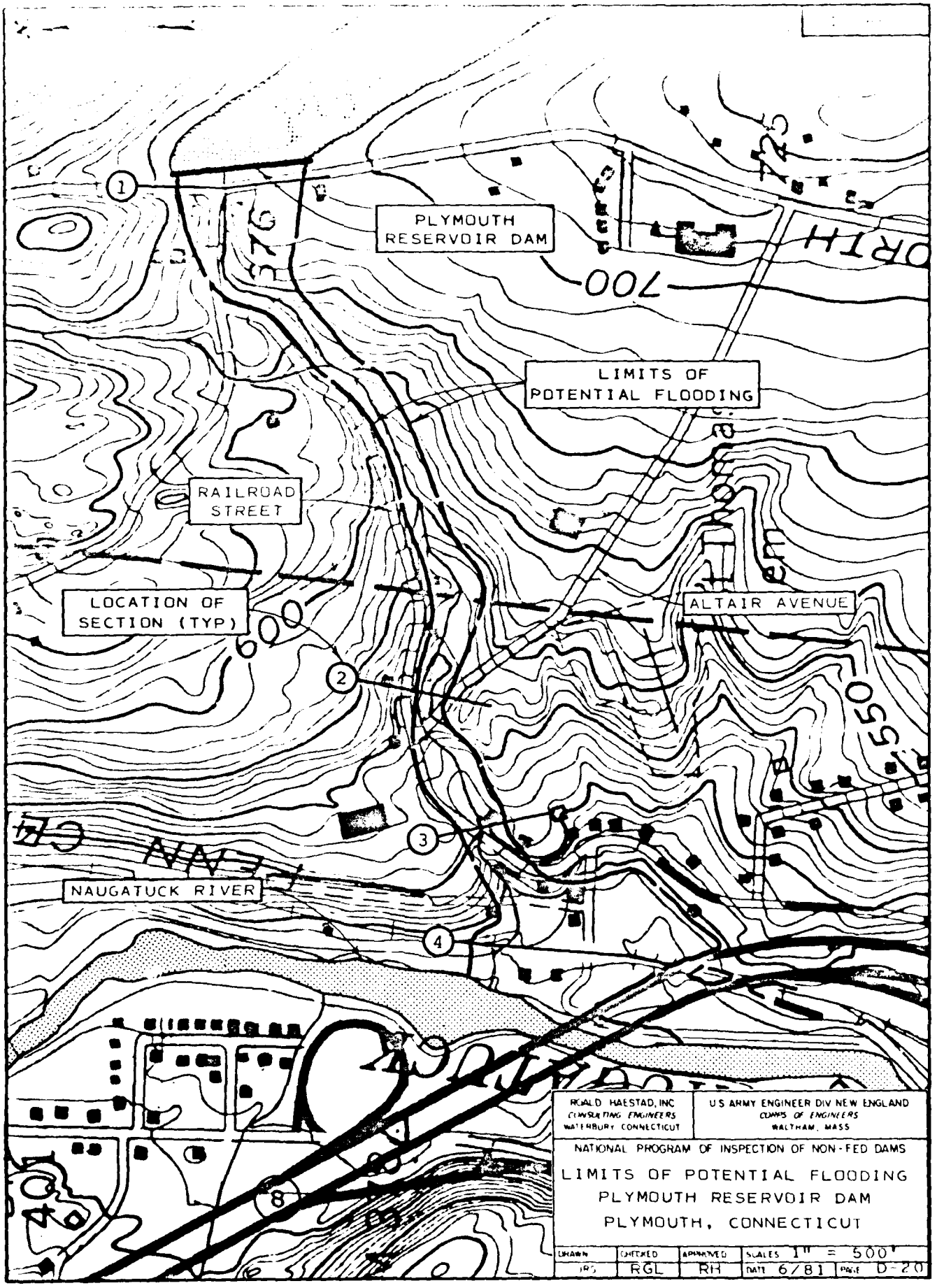
CKD BY SAH DATE 4-23-81 3 Brookside Road - Waterbury, Conn. 06708 JOB NO .....

SUBJECT PLANIMETER READINGS FOR FLOOD ROUTING

PLANIMETER READINGS:
(SCALE: 1" = 2000')

* WATER SURFACE: EL 692	THIRD	25.97 SQ. IN	0.38	34.89
	FIRST	25.22 SQ. IN	0.38	USE 34.9 ACRES
	START	24.84 SQ. IN.		
CONTOUR 700:	THIRD	4.85 SQ. IN.	0.54	49.59
	FIRST	3.78 SQ. IN	0.54	USE 49.6 ACRES
	START	3.24 SQ. IN.		
WATERSHED:	THIRD	29.34 SQ. IN	3.95	0.77 SQ. MI.
	FIRST	21.45 SQ. IN	3.95	
	START	17.50 SQ. IN.		

* THE CONNECTICUT WATER COMPANY SUPPLIED US WITH A WATER SURFACE AREA OF 36.7 ACRES AT SPILLWAY LEVEL. THIS VALUE WAS ASSUMED TO BE MORE ACCURATE THAN THE PLANIMETERED VALUE AND THEREFORE WAS USED IN IT'S PLACE.



RGALD HAESTAD, INC CONSULTING ENGINEERS WATERBURY CONNECTICUT	U S ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

LIMITS OF POTENTIAL FLOODING
PLYMOUTH RESERVOIR DAM
PLYMOUTH, CONNECTICUT

DRAWN	CHECKED	APPROVED	SCALES	
RPS	RGL	RH	1" = 500'	
			DATE 6/81	PAGE D-20

APPENDIX E

INFORMATION AS CONTAINED IN

THE NATIONAL INVENTORY OF DAMS

NOT AVAILABLE AT THIS TIME


ATE
LME